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Vineyard Wind 1 Offshore Wind Energy Project
Final Environmental Impact Statement
Volume I

March 2021

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ENVIRONMENTAL IMPACT STATEMENT
FOR THE VINEYARD WIND 1 OFFSHORE WIND ENERGY PROJECT
DRAFT ( ) FINAL (X) DRAFT SUPPLEMENTAL ( )

Lead Agency:	U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM), Office of Renewable Energy Programs
Cooperating Federal Agencies:	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service U.S. Department of Defense, Army Corps of Engineers U.S. Department of Homeland Security, Coast Guard U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement U.S. Environmental Protection Agency
Cooperating Tribal Nation:	Narragansett Indian Tribe
Cooperating State Agencies:	Massachusetts Office of Coastal Zone Management Rhode Island Coastal Resource Management Council Rhode Island Department of Environmental Management
Contact Person:	Jennifer Bucatari Environmental Protection Specialist Office of Renewable Energy Programs, Environment Branch Bureau of Ocean Energy Management Office (703) 787-1742 Jennifer.Bucatari@boem.gov
Area:	Lease Area OCS-A 0501

Abstract:

This Final Environmental Impact Statement (FEIS) assesses the potential environmental, social, economic, historic, and cultural impacts that could result from the construction, operation, maintenance, and decommissioning of an approximately 800-megawatt offshore wind energy facility located more than 14 miles (23.6 kilometers) southeast of Martha’s Vineyard. This Vineyard Wind 1 Offshore Wind Energy Project (Project) is proposed by Vineyard Wind LLC and designed to serve demand for renewable energy in New England. The FEIS was prepared following the requirements of the National Environmental Policy Act (42 United States Code [U.S.C.] §§ 4321–4370f) and implementing regulations. This FEIS incorporates analyses in the Supplement to the Draft Environmental Impact Statement (SEIS) addressing reasonably foreseeable offshore wind activities and their effects, previously unavailable fishing data, a new transit lane alternative, and changes to the proposed Project made by Vineyard Wind LLC. The FEIS also addresses comments received during the Draft Environmental Impact Statement (DEIS) and SEIS comment periods. The FEIS will inform BOEM in deciding whether to approve, approve with modifications, or disapprove the proposed Project. Cooperating agencies may also rely on the FEIS to support decision making if they determine the analysis is adequate for that purpose. BOEM’s action furthers U.S. policy to make the Outer Continental Shelf energy resources available for development in an expeditious and orderly manner, subject to environmental safeguards (43 U.S.C. § 1332(3)), including consideration of natural resources and existing ocean uses.

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EXECUTIVE SUMMARY

This Final Environmental Impact Statement (FEIS) assesses the potential environmental, social, economic, historic, and cultural impacts that could result from the construction, operation, maintenance, and eventual decommissioning of the Vineyard Wind 1 Offshore Wind Energy Project (Project) proposed by Vineyard Wind LLC (Vineyard Wind) in its Construction and Operations Plan (COP). Vineyard Wind's proposed Project would be located 14 miles (12 nautical miles) southeast of Martha's Vineyard and about 800 megawatts (MWs) in scale. The Project is designed to serve demand for renewable energy in New England. The Bureau of Ocean Energy Management (BOEM) has prepared this FEIS following the requirements of the National Environmental Policy Act (NEPA; 42 United States Code [U.S.C.] Sections [§§] 4321–4347) and implementing regulations.[1] This FEIS will inform BOEM in deciding whether to approve, approve with modifications, or disapprove the COP. This FEIS is not a decision document. After publication of this FEIS, NEPA requires BOEM to wait a minimum of 30 days before issuing a Record of Decision (ROD) that will state BOEM's decision on the COP. This FEIS incorporates the draft analyses presented in the previously published Draft Environmental Impact Statement (DEIS) and Supplement to the Draft EIS (SEIS).

Cooperating agencies may rely on this FEIS to support their decision-making. In conjunction with submitting its COP, Vineyard Wind 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 U.S.C. § 1361 et seq.) for incidental take of marine mammals during Project construction. NMFS is required to review applications and, if appropriate, issue an Incidental Take Authorization under the MMPA. In addition, NMFS has an independent responsibility to comply with NEPA and will rely on the information and analyses in BOEM's EIS to fulfill its NEPA obligations. NMFS intends to adopt the EIS and sign the ROD, if appropriate.[2] The U.S. Army Corps of Engineers similarly intends to adopt the EIS and sign the joint ROD in respect to its responsibilities under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899.

ES1. PURPOSE AND NEED FOR THE PROPOSED ACTION

Through a competitive leasing process pursuant to 30 Code of Federal Regulations (C.F.R.) § 585.211, Vineyard Wind was awarded Lease Area OCS-A 0501 offshore of Massachusetts and the exclusive right to submit a COP for activities within the lease area. Vineyard Wind has submitted a COP proposing the construction, operation, maintenance, and conceptual decommissioning of a commercial-scale, offshore wind energy facility within Lease Area OCS-A 0501. Vineyard Wind provided the most recent updates to this COP on September 30, 2020 (Epsilon 2018, 2019, 2020a, 2020b)[3]. Vineyard Wind plans to begin construction in 2021.

[1] On July 16, 2020, the Council on Environmental Quality (CEQ), which is responsible for federal agency implementation of NEPA, updated the regulations for implementing the procedural provisions of NEPA (85 Federal Register [Fed. Reg.] 43304–43376 [July 16, 2020]). Since BOEM's NEPA review of the proposed Project began prior to the September 14, 2020, effective date of the updated regulations, this FEIS was prepared under the previous version of the regulations (1978, as amended in 1986 and 2005). In addition, all 40 C.F.R. references are to the CEQ regulations in effect prior to September 14, 2020.

[2] If NMFS determines the FEIS is sufficient to support its decision under the MMPA.

[3] On December 1, 2020, Vineyard Wind withdrew the COP to conduct additional reviews associated with the inclusion of the General Electric Haliade-X Wind Turbine Generator into the final Project design. In response to Vineyard Wind's December 1, 2020, letter, BOEM published a Federal Register notice on December 16, 2020, informing the public that "preparation of an Environmental Impact Statement" for the COP was "no longer necessary" for the sole reason that "the COP ha[d] been withdrawn from review and decision-making" (85 Fed. Reg. 81486 [December 16, 2020]). Accordingly, BOEM "terminated" the "preparation and completion" of the EIS. On January 22, 2021, Vineyard Wind notified BOEM via letter that it had completed its review and had concluded that inclusion of the Haliade-X turbines did not warrant any modifications to the COP. Accordingly, Vineyard Wind informed BOEM that it was rescinding its temporary withdrawal and asked BOEM to resume its review of the COP. After conducting an independent review of the information provided by Vineyard Wind, BOEM has confirmed that: (1) the Haliade-X turbines fall within the design envelope analyzed in the June 2020 SEIS; (2) Vineyard Wind's already-submitted COP contains all the necessary information to complete the FEIS; and (3) an additional SEIS is not needed under 40 C.F.R. § 1502.9. BOEM will publish a Federal Register Notice informing stakeholders that it has resumed the NEPA process.

The purpose of the federal agency action in response to the Vineyard Wind Project COP (Epsilon 2018, 2019, 2020a, 2020b) is to determine whether to approve, approve with modifications, or disapprove the COP to construct, operate, and decommission an approximately 800-megawatt, commercial-scale wind energy facility within Lease Area OCS-A 0501 to meet New England's demand for renewable energy. More specifically, the proposed Project would deliver power to the New England energy grid to contribute to Massachusetts's renewable energy requirements—particularly, the Commonwealth's mandate that distribution companies jointly and competitively solicit proposals for offshore wind energy generation (220 Code of Massachusetts Regulations § 23.04(5)). BOEM's decision on Vineyard Wind's COP is needed to execute its duty to approve, approve with modifications, or disapprove the proposed Project in furtherance of the United States policy to make Outer Continental Shelf (OCS) energy resources available for expeditious and orderly development, subject to environmental safeguards (43 U.S.C. § 1332(3)), including consideration of natural resources and existing ocean uses.

ES2. PUBLIC INVOLVEMENT

Prior to preparation of the DEIS, BOEM held five public scoping meetings near the proposed Project area to solicit feedback and to identify issues and potential alternatives for consideration. The topics most referenced in the scoping comments included commercial fisheries and for-hire recreational fishing, Lewis Bay, the Project description, socioeconomics, and alternatives. On December 7, 2018, BOEM published a Notice of Availability for the DEIS consistent with the regulations implementing NEPA to assess the potential impacts of the Proposed Action and alternatives (Notice of Availability of a Draft Environmental Impact Statement for Vineyard Wind LLC's Proposed Wind Energy Facility Offshore Massachusetts, 83 Federal Register [Fed. Reg.] 63184–63185 [December 7, 2018]). The Notice of Availability commenced the public review and comment period of the DEIS. BOEM held five public hearings (February 11 to 15, 2019) in the vicinity of the proposed Project area to solicit feedback and identify issues for consideration in preparing the FEIS. Throughout the public review and comment period, federal agencies; state, local, and tribal governments; and the general public had the opportunity to provide comments on the DEIS.

The topics most referenced during the DEIS comment period included commercial fisheries and for-hire recreational fishing, mitigation, finfish, invertebrates, and essential fish habitat, and purpose and need. In addition, comments received from stakeholders and cooperating agencies on the DEIS requested BOEM to expand the cumulative impact analysis for the proposed Project. Considering such comments, and taking into account recent state offshore wind procurement announcements since DEIS publication, BOEM expanded its planned action analysis in its SEIS based on the determination that a greater build out of offshore wind capacity is reasonably foreseeable than was analyzed in the DEIS. The Notice of Availability for the SEIS was published on June 12, 2020. The Notice of Availability commenced another public review and comment period for the proposed Project. Throughout the public review and comment period, federal agencies; state, local, and tribal governments; and the general public had the opportunity to provide comments on the SEIS in various ways. In addition, BOEM held five virtual public meetings via Zoom in late June, early July 2020. The topics most referenced during the SEIS comment period included commercial fisheries and for-hire recreational fishing, planned action analysis impacts, employment and economics, alternatives, and purpose and need. BOEM reviewed and considered all public submissions in the development of this FEIS.

ES3. ENVIRONMENTAL IMPACTS

This FEIS incorporates the draft analyses presented in the previously published DEIS and SEIS. The FEIS presents resource-specific baseline conditions and, using the methodology and assumptions outlined in Chapter 1 and Appendix A, assesses impacts that could result from the incremental impact of the Proposed Action and action alternatives when combined with past, present, or reasonably foreseeable activities, including other future offshore wind activities. Public and agency comments received during the DEIS and SEIS comment periods were also assessed and used to prepare this FEIS.

In addition the NEPA-implementing regulations (40 C.F.R. § 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 on 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 C describes those potential unavoidable adverse impacts for the Proposed Action. Most potential unavoidable adverse impacts associated with the Proposed Action, such as disturbance of habitat or incremental disruption of typical daily activities, would occur during the construction phase and would be temporary. Appendix C also describes irreversible and irretrievable commitment of resources by resource. 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.

ES4. ALTERNATIVES

This FEIS evaluates five action alternatives (one of which has two sub-alternatives) and the No Action Alternative for the proposed Project (Section 2.1 includes additional information) as follows:

- Alternative A—Proposed Action[4]
- Alternative C—No Surface Occupancy in the Northernmost Portion of the Project Area Alternative
- Alternative D—Wind Turbine Layout Modification Alternative
  - Alternative D1—One-Nautical Mile Wind Turbine Spacing Alternative
  - Alternative D2—East-West and One-Nautical Mile Wind Turbine Layout Alternative
- Alternative E—Reduced Project Size Alternative
- Alternative F—Vessel Transit Lane Alternative
- Alternative G—No Action Alternative

ES4.1. ALTERNATIVE A—PROPOSED ACTION

Alternative A would include up to 100 wind turbine generators (WTGs), each of which would have an 8 to 14 MW generation capacity, and up to two electrical service platforms (ESPs). The WTGs would be placed in a grid-like array (with WTGs in rows oriented northeast-southwest and northwest-southeast) within the Vineyard Wind lease area, referred to as the Wind Development Area (WDA), with typical spacing between WTGs of 0.75 to 1 nautical mile.[5] Vineyard Wind has proposed the Project using a Project Design Envelope (PDE) framework, under which multiple aspects of the Project are potentially variable, but would remain within the limits defined in the PDE. As shown in Appendix G, Figure G-1, the General Electric Haliade-X, which would be designed specifically for the proposed Project, would fit within the parameters of the Vineyard Wind PDE presented in the COP.

Changes have been made to the proposed Project and its related PDE since publication of the DEIS and were incorporated into the SEIS, and these changes are summarized below in Table ES-1 and described in Section 2.1.1 of this FEIS. To the extent they are applicable, these changes are also analyzed in the action alternatives assessed in this document.

[4] The DEIS and SEIS contemplated two Onshore Export Cable Routes (OECRs), with alternative options within each route; however, since the publication of the SEIS, Vineyard Wind has stated all necessary state and local permits for the Covell's Beach landfall location have been acquired. Therefore, the Proposed Action (Alternative A) and action alternatives only contemplate the Covell's Beach landfall and onshore route, and Alternative B is no longer evaluated as an action alternative in this FEIS. The identification of the action alternatives will maintain the same lettering (Pachter, Pers. Comm., June 26, 2020).

[5] The minimum distance between nearest turbines is no less than 0.65 nautical miles, the maximum distance is no more than 1.1 nautical miles and the average spacing between turbines is approximately 0.86 nautical mile (COP Section 3.1.1.1, Volume I; Epsilon 2020a).

Table ES-1: Changes to the Limits of the Proposed Project Design Envelope

Envelope Parameter	Previous Limit	Current Limit
Total Number of Turbines	Up to 100	57 to 100
Total Facility Capacity	~800 MW [a]	~800 MW [a]
Maximum Turbine Generation Capacity	10 MW	14 MW
Maximum Tip Height	696 feet (212 meters) MLLW [b]	837 feet (255 meters) MLLW [b]
Maximum Hub Height	397 feet (121 meters) MLLW [b]	473 feet (144 meters) MLLW [b]
Maximum Rotor Diameter	591 feet (180 meters) MLLW [b]	729 feet (222 meters) MLLW [b]
Maximum Tip Clearance	102 feet (31 meters) MLLW [b]	105 feet (32 meters) MLLW [b]
Substation Footprint	6.4 acres (25,899.9 m^2)	8.6 acres (34,803.1 m^2)

m^2 = square meters; MLLW = above mean lower low water; MW = megawatt
[a] Vineyard Wind's Proposed Action is for an 800 MW offshore wind energy project. This FEIS evaluates the potential impacts of a facility up to 800 MW to ensure that it covers projects constructed with a smaller capacity.
[b] Elevations relative to mean higher high water are approximately 3 feet (1 meter) lower than those relative to MLLW.

Offshore and onshore cables would transmit electricity to a proposed onshore substation. The Proposed Action would make landfall at Covell's Beach in the Town of Barnstable. Table ES-2 summarizes the key parameters of the Proposed Action, while Figure ES-1 shows the Proposed Action. The key parameters presented in Table ES-2 have not changed since the publication of the SEIS or as a result of the resubmitted January 2021 COP. See Section 2.1.1 for additional information on the Proposed Action.

Table ES-2: Proposed Action Design Envelope Parameters

Capacity and Arrangement		
Wind Facility Capacity	Approximately 800 MW [a]	
Wind Turbine Generator Foundation Arrangement Envelope	Up to 100 monopiles	Up to 10 may be jacket foundations
Wind Turbine Generators (WTGs)	**Minimum**	**Maximum**
Turbine Generation Capacity	8 MW	14 MW
Number of Turbine Positions [b]	57	106
Number of Turbines Installed	57	Up to 100
Total Tip Height	627 ft (191 m) MLLW [c]	837 ft (255 m) MLLW [c]
Hub Height	358 ft (109 m) MLLW [c]	473 ft (144 m) MLLW [c]
Rotor Diameter	538 ft (164 m) MLLW	729 ft (222 m) MLLW
Tip Clearance	89 ft (27 m) MLLW [c]	105 ft (32 m) MLLW [c]
Platform Level/Interface Level Height for Monopile	62 ft (19 m) MLLW [c]	75 ft (23 m) MLLW [c]
Tower Diameter for WTG	20 ft (6 m)	28 ft (8.5 m)
Monopile Foundations	**Minimum**	**Maximum**
Diameter	25 ft (7.5 m)	34 ft (10.3 m)
Pile footprint	490 ft^2 (45.5 m^2)	908 ft^2 (84.3 m^2)
Height between Seabed and MLLW (water depth)	121 ft (37 m)	162 ft (49.5 m)
Penetration	66 ft (20 m)	148 ft (45 m)
Transition Piece Tower Diameter	20 ft (6 m)	28 ft (8.5 m)
Transition Piece Length	59 ft (18 m)	98 ft (30 m)
Platform Level/Interface Level Height	62 ft (19.5 m)	75 ft (22.5 m)
Number of Piles/Foundation	1	1
Number of Piles Driven/Day within 24 hours [d]	1	2
Typical Foundation Time to Pile Drive [e]	approximately 3 hours	approximately 3 hours
Hammer size	Up to 4,000 kJ	Up to 4,000 kJ
Jacket (Pin Piles) Foundation	**Minimum**	**Maximum**
Diameter for WTG and ESP	5 ft (1.5 m)	10 ft (3 m)
Jacket Structure Height for WTG	180 ft (55 m)	262 ft (80 m)
Jacket Structure Height for ESP	180 ft (55 m)	213 ft (65 m)
Platform Level/Interface Level Height for WTG and ESP	74 ft (22.5 m) MLLW	94 ft (28.5 m) MLLW
Pile Penetration for WTG	98 ft (30 m)	197 ft (60 m)
Pile Penetration for ESP	98 ft (30 m)	246 ft (75 m)

Capacity and Arrangement		
Pile Footprint for WTG	59 ft (18 m)	115 ft (35 m)
Pile Footprint for ESP	59 ft (18 m)	248 ft (45 m)
Number of Piles/Foundation	3 to 4	3 to 4
Number of Piles Driven/Day within 24 Hours [d]	1 (up to 4 pin piles)	
Typical Foundation Time to Pile Drive [e]	approximately 3 hours	
Hammer Size	Up to 3,000 kJ	
Scour Protection for Foundations	**Minimum**	**Maximum**
Scour Protection Area at Each Monopile WTG and ESP	up to 16,146 ft^2 (1,500 m^2)	up to 22,600 ft^2 (2,100 m^2)
Scour Protection Volume at Each Monopile WTG and ESP	up to 52,972 ft^3 (1,500 m^3)	up to 127,133 ft^3 (3,600 m^3)
Scour Protection Area at Each Jacket WTG	up to 13,993 ft^2 (1,300 m^2)	up to 19,375 ft^2 (1,800 m^2)
Scour Protection Volume at Each Jacket WTG	up to 45,909 ft^3 (1,300 m^3)	up to 91,818 ft^3 (2,600 m^3)
Scour Protection Area at Each Jacket ESP	up to 13,993 ft^2 (1,300 m^2)	up to 26,900 ft^2 (2,500 m^2)
Scour Protection Volume at Each Jacket ESP	up to 45,909 ft^3 (1,300 m^3)	up to 134,196 ft^3 (3,800 m^3)
Electrical Service Platform (ESP)		
Maximum Dimensions	148 ft x 230 ft x 125 ft (45 m x 70 m x 38 m)	
Number of Conventional ESPs	1 (800 MW)	2 (400 MW each)
Number of Transformers per ESP	1	2
Foundation Type	Monopile	Jacket
Number of Piles/Foundation	1	3 to 4
Maximum Height	215 ft (65.5 m) MLLW	218 ft (66.5 m) MLLW
Inter-Array Cable (66 kV)	**Minimum**	**Maximum**
Number of Foundations per Inter-Array Cable	6	10
Inter-Array Cable Length		171 mi (275 km)
Protection Method (rock placement, concrete mattresses, half-shell)		Up to 10% of route
Target Burial Depth	5 ft (1.5 m)	8 ft (2.5 m)
Export and Inter-Link Cable (220 kV)	**Minimum**	**Maximum**
Number of Export Cables within Corridor		2
Target Burial Depth	5 ft (1.5 m)	8 ft (2.5 m)
Maximum Length of Export Cable (assuming two cables)		98 mi (158 km)
Typical separation distance of Export Cable (assuming two cables)		328 ft (100 m)
Total Corridor Width for Export Cable (two cables) [f]	2,657 ft (810 m)	3,280 ft (1,000 m)
Protection Method (rock placement, concrete mattresses, half-shell)		Up to 10% of route
Maximum Length of Inter-Link Cable		6.2 mi (10 km)
Export Cables Dredging (width corridor per cable)		65.6 ft (20 m)
Export Cables Total Dredging Area		up to 69 acres (0.28 km^2)
Export Cables Total Dredging Volume		up to 214,500 cy (164,000 m^3)

cy = cubic yards; ESP = electrical service platform; ft = foot; ft^2 = square feet; ft^3 = cubic feet; kJ = kilojoule; km = kilometer; km^2 = square kilometers; kV = kilovolt; m = meter; m^2 = square meters; m^3 = cubic meters; mi = mile; MLLW = mean lower low water; MW = megawatt; WTG = wind turbine generator

[a] Vineyard Wind's Proposed Action is for an approximately 800 MW offshore wind energy project. This FEIS evaluates the potential impacts of a facility up to 800 MW to ensure that it covers projects constructed with a smaller capacity.

[b] Additional WTG positions allow for spare turbine locations or additional capacity to account for environmental or engineering challenges.

[c] Elevations relative to mean higher high water are approximately 3 feet (1 meter) lower than those relative to MLLW.

[d] Work would not be performed concurrently. No drilling is anticipated; however, it may be required if a large boulder or refusal is met. If drilling is required, a rotary drilling unit would be mobilized. Similarly, vibratory hammering could be used if deemed appropriate by the installation contractor.

[e] Vineyard Wind has estimated that typical pile driving for a monopile is expected to take less than approximately 3 hours to achieve the target penetration depth, and that pile driving for the jacket foundation would take approximately 3 hours to achieve the target penetration depth. Different hammer sizes are used for installation of the monopile and jacket foundations.

[f] Corridor width for siting purposes; each trench would be approximately 3.2 feet (1 meter) wide and there would be an up to 3.3 to 6.6-foot-wide (1- to 2-meter-wide) temporary disturbance zone from the tracks or skids of the cable installation.

ES4.1.1. Construction and Installation

The Proposed Action would include the construction and installation of both onshore and offshore facilities. Construction and installation is expected to begin in the first quarter of 2021 and be completed by the second quarter of 2024. Vineyard Wind anticipates beginning land-based construction before the offshore components. Vineyard Wind submitted an updated construction schedule to BOEM in January 2021 (Vineyard Wind 2021). The following is expected: construction of the Onshore Export Cable Route (OECR) would begin in first quarter 2021; construction of the onshore substation would begin in third quarter 2021; construction within the Offshore Export Cable Corridor (OECC) would begin in second quarter 2022; turbine and ESP installation would begin second quarter 2023; and inter-array cable installation would begin in third quarter 2023. The majority of land-based construction activities would occur outside of the summer tourist season.

Onshore elements of the Proposed Action would include the landfall site, the onshore export cables, the onshore substation site, and the connection from the proposed substation site to the existing bulk power grid (Figure ES-1). Most of the proposed OECR (approximately 5.3 miles [8.5 kilometers]) would pass through already developed areas, primarily paved roads and existing utility rights-of-way (ROWs), and would be entirely underground. The onshore export cables would terminate at the proposed substation, which would have an area of approximately 7.7 acres (31,161 square meters [m^2]) on a currently forested site adjacent to an existing electrical substation and other commercial and industrial uses.

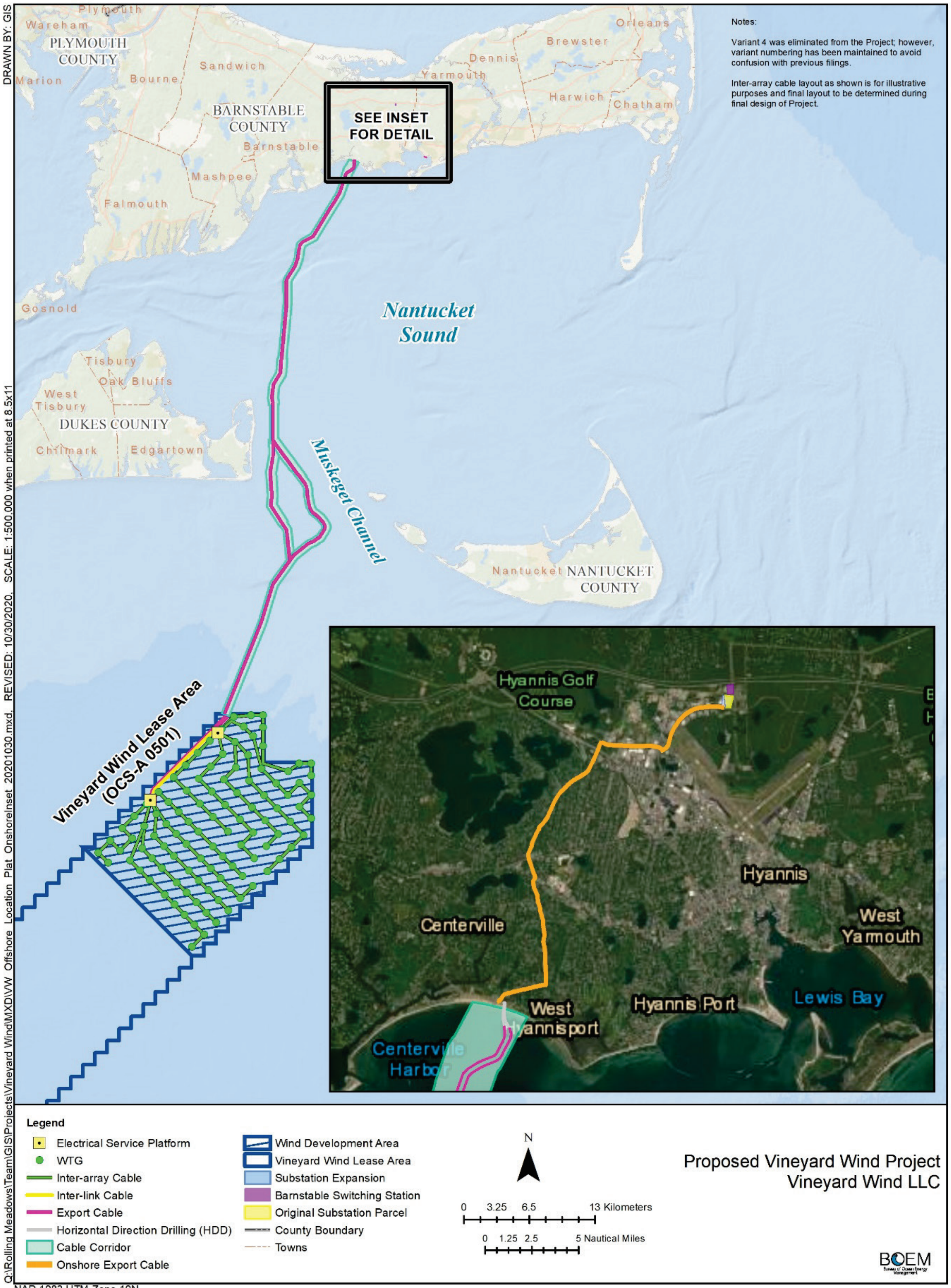
Offshore Project elements would include WTGs and ESPs and their foundations, scour protection for all foundations, inter-array cables that connect the WTGs to the ESPs, the inter-link cable that connects the ESPs, and the OECC to the landfall location. The proposed offshore Project elements are located within federal waters, with the exception of a portion of the OECC located within state waters.

As part of the PDE, Vineyard Wind has proposed several cable route installation methods for the inter-array cables, inter-link cables, and offshore export cables. Vineyard Wind would bury the cables using a jet plow, mechanical plow, and/or mechanical trenching, as suited for the bottom type in the immediate area. Dredging may be necessary in some areas, especially where large sand waves occur.

Vineyard Wind would use vessels, vehicles, and aircraft during construction, operations and maintenance, and decommissioning. The majority of vessels and vehicles would be based out of the New Bedford, Massachusetts, Marine Commerce Terminal and smaller purpose-built Operations and Maintenance Facilities in Vineyard Haven, Massachusetts.

ES4.1.2. Decommissioning

According to 30 C.F.R. Part 585 and other BOEM requirements, Vineyard Wind would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. All foundations would need to be removed to a depth of 15 feet (4.6 meters) below the mudline (30 C.F.R. § 585.910(a)). Absent permission from BOEM, Vineyard Wind would have to complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed. BOEM would require Vineyard 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 C.F.R. § 585.905). Although the proposed Project has a designed life span of 30 years, some installations and components may remain fit for continued service after this time. Vineyard Wind would have to apply for an extension if it wanted to operate the proposed Project for more than the operations term.



Note: The inter-array cable layout shown is an example. The final cable layout and location would be within the approved PDE.

Figure ES-1: Proposed Project Elements

ES4.2. ALTERNATIVE C—NO SURFACE OCCUPANCY IN THE NORTHERNMOST PORTION OF THE PROJECT AREA

This alternative would prohibit surface occupancy in the northern/northeastern-most portion of the WDA, resulting in the relocation of the six northernmost WTGs to the southern portion of the WDA. See Section 2.1.2 for additional information on Alternative C.

ES4.3. ALTERNATIVE D—WIND TURBINE LAYOUT MODIFICATION

Alternative D includes two sub-alternatives, both of which would involve different WTG layouts. See Section 2.1.3 for additional information on Alternative D. Neither sub-alternative would have a designated transit corridor; both sub-alternatives would increase the WDA area by approximately 22 percent. Prior to COP approval, BOEM would require substantial additional survey work for the two sub-alternatives to resolve data gaps for WTG placements and inter-array cable locations not contemplated in Alternative A (the Proposed Action).

- **Alternative D1** would require a minimum spacing of 1 nautical mile between WTGs.
- **Alternative D2** would arrange the WTG layout in an east-west orientation, and would require a minimum spacing of 1 nautical mile between WTGs. This alternative would be consistent with the Final Massachusetts and Rhode Island Port Access Route Study (MARIPARS) and the Rhode Island and Massachusetts Lease Area developers' agreement.[6]

ES4.4. ALTERNATIVE E—REDUCED PROJECT SIZE

This alternative would limit the proposed Project to up to 84 WTGs. Under this alternative, depending on the turbine capacity used, this alternative could involve as few as 57 WTGs or as many as 84 WTGs. See Section 2.1.4 for additional information on Alternative E.

ES4.5. NEW ALTERNATIVE F—VESSEL TRANSIT LANE ALTERNATIVE

This alternative would include a vessel transit lane through the WDA where no surface occupancy would occur. The lane included in this alternative, and not included in other alternatives, could potentially facilitate transit of vessels through the WDA from southern New England ports—primarily New Bedford—to fishing areas on Georges Bank. WTG locations displaced by the transit lane would not be eliminated from consideration, but are assumed to move the proposed Project south of the WDA within the existing Vineyard Wind lease area. This alternative will disclose the effect a transit lane could have on the expected effects from the other action alternatives analyzed in this FEIS. See Section 2.1.5 for additional information on Alternative F.

[6] Small variances throughout a wind energy facility should not significantly affect safety of navigation. The 2020 Final Massachusetts and Rhode Island Port Access Route Study (MARIPARS; USCG 2020: https://www.federalregister.gov/documents/2020/01/29/2020-01522/port-access-route-study-the-areas-offshore-of-massachusetts-and-rhode-island) provided quantitatively derived recommendations for turbine spacing and transit lane widths within the wind arrays. For an array developed in a uniform grid, aligned along cardinal headings with 1-nautical-mile spacing, the diagonal lanes would be approximately 0.7 nautical mile wide. The MARIPARS concluded that "(1) lanes for vessel transit should be oriented in a northwest to southeast direction, 0.6 NM [nautical mile] to 0.8 NM wide. This width will allow vessels the ability to maneuver in accordance with the COLREGS [International Regulations for Preventing Collisions at Sea] while transiting through the RI/MA WEA [Rhode Island/Massachusetts Wind Energy Area]; (2) lanes for commercial fishing vessels actively engaged in fishing should be oriented in an east to west direction, 1 NM wide; and (3) lanes for USCG search and rescue operations should be oriented in a north to south and east to west direction, 1 NM wide. This will ensure two lines of orientation for USCG helicopters to conduct search and rescue operations" (USCG 2020). If approved, BOEM plans on requiring as a condition of COP approval that any movements in turbine location, as may be permissible pursuant to 30 C.F.R. § 585.634, do not shrink the diagonal lanes to less than 0.6 nautical mile.

ES4.6. ALTERNATIVE G—NO ACTION ALTERNATIVE

Under the No Action Alternative, BOEM would not approve the proposed Project, and none of the environmental consequences or benefits of the proposed Project would occur. This would not preclude BOEM from considering other proposals in this area or similar proposals in other areas. See Section 2.1.6 for additional information on Alternative G.

ES4.7. PREFERRED ALTERNATIVE

The Council on Environmental Quality (CEQ) NEPA regulations require the identification of a preferred alternative in the FEIS.[7] 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 implement the preferred alternative.

BOEM has identified the combination of Alternatives C (No Surface Occupancy in the Northernmost Portion of the Project Area Alternative), D2 (East-West and One-Nautical-Mile Turbine Layout), and E (Reduced Project Size Alternative) as its preferred alternative (Preferred Alternative) (Figure ES-2).[8] The Preferred Alternative would entail the construction, operation, maintenance, and eventual decommissioning of an 800 MW large-scale commercial wind energy facility consisting of no more than 84 WTGs in the OCS offshore Massachusetts within the proposed WDA with the export cable making landfall at Covell's Beach. The Preferred Alternative would allow up to 84 turbines to be installed in 100 of the 106 proposed locations and would prohibit the installation of WTGs in 6 locations in the northernmost portion of the WDA. The Preferred Alternative would require the WTGs to be arranged in a north-south and east-west orientation with a minimum spacing of 1 nautical mile between them. The Preferred Alternative would conform to the design parameter ranges outlined in the Vineyard Wind COP, which includes measures that Vineyard Wind has voluntarily committed to implement to avoid or reduce impacts, except that cabling is likely to exceed the COP design parameters. Impacts from such additional cabling have been considered within this FEIS.

BOEM's Preferred Alternative includes mitigation and monitoring measures to avoid or reduce impacts on existing ocean uses and on environmental and socioeconomic resources associated with construction, operation, and maintenance activities across the various resource areas analyzed in this document. Table D-1 in Appendix D contains resource-by-resource details on mitigation and monitoring measures considered for the Proposed Action, other action alternatives, and BOEM's Preferred Alternative. Impacts from BOEM's Preferred Alternative have been determined to be within the scope of effects analyzed in the Final NMFS Biological Opinion (BO) and in the proposed NMFS Incidental Harassment Authorization. If a mitigation measure is incorporated in this FEIS analysis as a result of a consultation (such as NMFS BO or MMPA Incidental Harassment Authorization), the measure will be included as a condition in the ROD.

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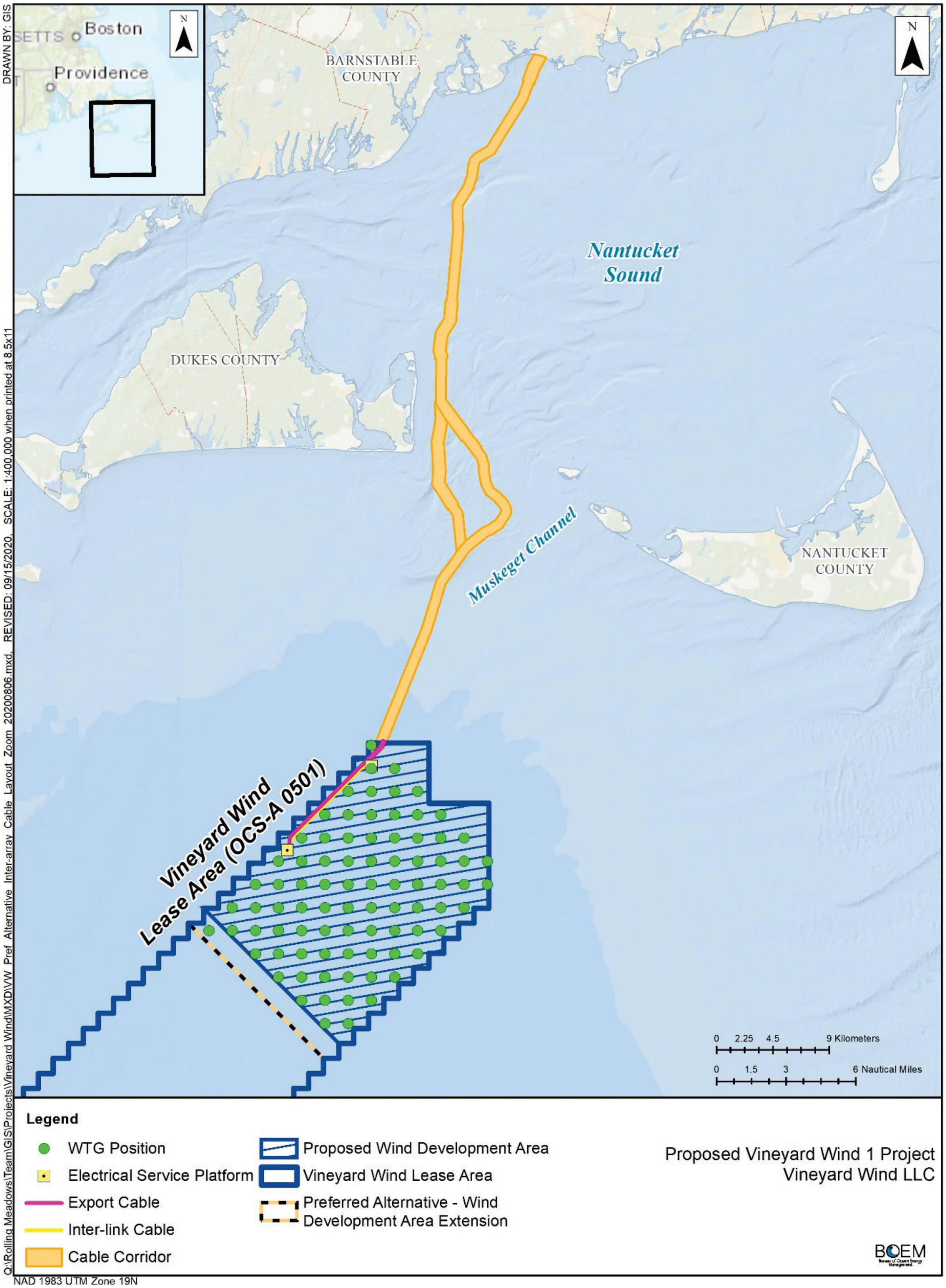
[7] Identification of a preferred alternative for an FEIS is required by both the CEQ NEPA regulations issued on July 16, 2020 (85 Fed. Reg. 43304–43376.) and the regulations in place previously (CEQ 2005). To note, the new regulations provide that the "regulations in this subchapter apply to any NEPA process begun after September 14, 2020. An agency may apply the regulations in this subchapter to ongoing activities and environmental documents begun before September 14, 2020" (85 Fed. Reg. 43372-73 [July 16, 2020]; 40 C.F.R. § 1506.13). The Vineyard Wind NEPA process is well underway, and BOEM has chosen to follow the previous long-standing CEQ NEPA regulations on this and other matters concerning the Vineyard Wind EIS as well as the existing Department of the Interior NEPA regulations that are based on the previous CEQ NEPA regulations (43 C.F.R. Part 46).

[8] On June 26, 2020, Vineyard Wind informed BOEM that it is no longer pursuing the New Hampshire Avenue landing site. Although the New Hampshire Avenue site was included in the COP, Vineyard Wind has obtained all of the state and local permits necessary to bring the cable onshore at the Covell's Beach landing site. Further, Vineyard Wind has indicated it would remove this landfall from its COP, which would eliminate Alternative B. Therefore, Alternative B is equivalent to the Proposed Action and not discussed or considered further in this document. As stated in the DEIS, the alternatives are not mutually exclusive, and BOEM could "mix and match" multiple listed alternatives to result in a preferred alternative so long as crucial design parameters are compatible. Because Alternatives C, D2, and E are compatible, BOEM has selected this combination as the Preferred Alternative.



Note: The inter-array cable layout shown is an example, and the final layout and location of the cables would be located within the approved PDE. The up to 84 WTGs would be located within 100 of 106 locations presented as part of the Vineyard Wind PDE, and the cable route from the WDA to Covell's Beach would follow one of two options through Muskeget Channel.

Figure ES-2: Preferred Alternative Project Elements

ES4.8. COMPARISON OF IMPACTS BY ACTION ALTERNATIVE

Table ES-3 summarizes and compares the impacts under each action alternative. Tables 3-1 and 3-2 in Appendix B provide definitions for **negligible**, **minor**, **moderate**, and **major** impacts. Resources with overall adverse impact ratings no greater than **minor** (green) are analyzed in Appendix A, and the more impacted resources are analyzed in Chapter 3. All impact levels are assumed to be adverse unless specified as beneficial. Where impacts are presented as multiple levels, the table color represents the most adverse level of impact. Although the detailed description of potential impacts could vary across action alternatives, as described in Chapter 3 and Appendix A, many of the differences in potential impacts across alternatives do not warrant differences in the impact ratings determined based on the definitions used.

Under Alternative G (No Action), any potential environmental and socioeconomic impacts, including benefits, associated with the proposed Project would not occur; however, impacts could occur from other activities as described in Chapter 3.

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Table ES-3: Impacts by Action Alternative Resource Affected [a]

Resources	Proposed Action	Alternative C	Alternative D1	Alternative D2	Alternative E	Alternative F	Preferred Alternative
Coastal Habitats: *Project Impacts*	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**
Coastal Habitats: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Benthic Resources: *Project Impacts*	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**
Benthic Resources: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Finfish, Invertebrates, and Essential Fish Habitat: *Project Impacts*	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**
Finfish, Invertebrates, and Essential Fish Habitat: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Marine Mammals: *Project Impacts*	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**
Marine Mammals: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Sea Turtles: *Project Impacts*	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially minor **beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**
Sea Turtles: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Demographics, Employment, and Economics: *Project Impacts*	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**
Demographics, Employment, and Economics: *Planned Actions with Project Impacts*	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**
Environmental Justice: *Project Impacts*	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects
Environmental Justice: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Cultural, Historical, and Archaeological Resources: *Project Impacts*	**Negligible** to **major**, depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected	**Minor** to **major,** depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected
Cultural, Historical, and Archaeological Resources: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Recreation and Tourism: *Project Impacts*	**Negligible to moderate** and **negligible** to **minor beneficial**	**Negligible to moderate** and **negligible** to **minor beneficial**	**Negligible to moderate** and **negligible** to **minor beneficial**	**Negligible to moderate** and **negligible** to **minor beneficial**	**Negligible to moderate** and **negligible** to **minor beneficial**	**Negligible to moderate** and **negligible** to **minor beneficial**	**Negligible to moderate** and **negligible** to **minor beneficial**
Recreation and Tourism: *Planned Actions with Project Impacts*	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**
Commercial Fisheries and For-Hire Recreational Fishing: *Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Commercial Fisheries and For-Hire Recreational Fishing: *Planned Actions with Project Impacts*	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**
Navigation and Vessel Traffic: *Project Impacts*	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**
Navigation and Vessel Traffic: *Planned Actions with Project Impacts*	**Major**	**Major**	**Major**	**Moderate**	**Major**	**Moderate to Major**	**Moderate**

Resources	Proposed Action	Alternative C	Alternative D1	Alternative D2	Alternative E	Alternative F	Preferred Alternative
Other Uses: *Project Impacts*	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**
Other Uses: *Planned Actions with Project Impacts*	Military and national security: **minor** for most but **major** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **major** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **major** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **major** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **major** for search and rescue activities, except for **moderate** with combined with Alternative D2 Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities, Aviation and air traffic: **minor** Cables and pipelines: **negligible** Radar systems: **moderate** Scientific research and surveys: **major**
Air Quality: *Project Impacts*	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**
Air Quality: *Planned Actions with Project Impacts*	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**
Water Quality: *Project Impacts*	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**
Water Quality: *Planned Actions with Project Impacts*	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**
Birds: *Project Impacts*	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**
Birds: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Bats: *Project Impacts*	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Bats: *Planned Actions with Project Impacts*	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Terrestrial and Coastal Fauna: *Project Impacts*	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**
Terrestrial and Coastal Fauna*: Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Land Use and Coastal Infrastructure: *Project Impacts*	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**
Land Use and Coastal Infrastructure: *Planned Actions with Project Impacts*	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**

[a] As specified above, the Proposed Action (Alternative A) and action alternatives only contemplate the Covell's Beach landfall and onshore route. Therefore, Alternative B is no longer evaluated as an action alternative in this FEIS.

Impact rating colors are as follows: orange = **major**; yellow = **moderate**; green = **minor**; light green = **negligible** or **beneficial** to any degree. 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. The details of particular impacts and explanations for ranges of impact levels are found in each resource section.

ES4.9. REFERENCES

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VOLUME I—TABLE OF CONTENTS

LIST OF TABLES

Note: Appendix B includes all other tables not listed below.

LIST OF FIGURES

Note: Appendix B includes all other figures not listed below.

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

Acronym	Definition
§	Section
°C	degrees Celsius
°F	degrees Fahrenheit
μPa	micropascal
μPa^2	micropascal squared
μPa^2s	micropascal squared second
μT	microtesla
AC	alternating current
ADLS	Aircraft Detection Light System
AIS	automatic identification system
AMSL	above mean sea level
APE	area of potential effect
ARSR	Air Route Surveillance Radar
ASMFC	Atlantic States Marine Fisheries Commission
ASR	Airport Surveillance Radar
ATON	aids to navigation
AWEA	American Wind Energy Association
BA	Biological Assessment
BMP	best management practice
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
Btu	British thermal unit
CEQ	Council on Environmental Quality
C.F.R.	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
COLREGS	International Regulations for Preventing Collisions at Sea 1972
COP	Construction and Operations Plan
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
D	distance proportional to the pile diameter
dB	decibel
dB re 1μPa	decibels relative to one micropascal
DEIR	Draft Environmental Impact Report
DEIS	Draft Environmental Impact Statement
DP	dynamic positioning
DPS	distinct population segment
DRI	Development of Regional Impact
DTS	Distributed Temperature Sensing System
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EFSB	Energy Facilities Siting Board
EIS	Environmental Impact Statement
EMF	electromagnetic field
EO	Executive Order
ESA	Endangered Species Act
ESP	electrical service platform
FAA	Federal Aviation Administration
FAD	fish aggregating devices
FCC	Federal Communications Commission
FDR	Facility Design Report
Fed. Reg.	Federal Register
FEIS	Final Environmental Impact Statement
FMP	Fisheries Management Plan
FTE	full time equivalent
G&G	Geological and Geophysical
GDP	gross domestic product
GHG	greenhouse gas
GLD	geographic location description
GPS	global positioning system
GW	gigawatts
HAPC	Habitat Area of Particular Concern
hazmat	hazardous materials
HCA	Host Community Agreement
HDD	horizontal directional drilling
HMS	Highly Migratory Species
HRG	High Resolution Geophysical
Hz	hertz
IHA	Incidental Harassment Authorization
IPF	impact-producing factor
ITA	Incidental Take Authorization
ITS	Incidental Take Statement
kHz	kilohertz
kJ	kilojoule
km^2	square kilometers
KP	kilometer post
kph	kilometers per hour

Acronym	Definition
kV	kilovolt
LE_{24}	cumulative sound exposure over 24 hours
LME	Large Marine Ecosystem
m^2	square meters
MA DMF	Massachusetts Division of Marine Fisheries
MARIPARS	Massachusetts and Rhode Island Port Access Route Study
Massachusetts	Commonwealth of Massachusetts
MassCEC	Massachusetts Clean Energy Center
MassDEP	Massachusetts Department of Environmental Protection
MBUAR	Massachusetts Board of Underwater Archeological Resources
MCT	New Bedford Marine Commerce Terminal
met	meteorological
MEPA	Massachusetts Environmental Policy Act
mg/L	milligrams per liter
MHC	Massachusetts Historical Commission
MLLW	mean lower low water
MMPA	Marine Mammal Protection Act
MOA	Memorandum of Agreement
mph	miles per hour
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MW	megawatt
MW/nm^2	megawatt per square nautical mile
na	not available
NA	not applicable
NARW	North Atlantic right whale
Navy	United States Navy
NEFSC	New England Fishery Science Center
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar
NHESP	Massachusetts Natural Heritage and Endangered Species Program
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
nm^2	square nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

Acronym	Definition
NORAD	North American Aerospace Defense Command
NPDES	National Pollutant Discharge Elimination System
NRA	Navigational Risk Assessment
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NROC	Northeast Regional Ocean Council
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OECC	Offshore Export Cable Corridor(s)
OECR	Onshore Export Cable Route
OREC	Offshore Wind Renewable Energy Credit
PAM	passive acoustic monitoring
PATON	private aid to navigation
PDE	Project Design Envelope
$PM_{2.5}$	particulate matter with diameters 2.5 microns and smaller
PM_{10}	particulate matter with diameters 10 microns and smaller
PPA	Power Purchase Agreement
ProvPort	Port of Providence
Project	Vineyard Wind 1 Offshore Wind Energy Project
PSO	protected species observer
PTS	permanent threshold shift
RAM	Radar Adverse Impact Management
RI and MA Lease Areas	Rhode Island and Massachusetts Lease Areas
RI DEM	Rhode Island Department of Environmental Management
RMS	root mean squared
ROD	Record of Decision
RODA	Responsible Offshore Development Alliance
ROV	remotely operated vehicle
ROW	right-of-way
SAR	search and rescue
SEIS	Supplement to the Draft EIS
SOLAS	International Convention for the Safety of Life at Sea
SOV	service operations vessel
SPL	sound pressure level
SPUE	sightings per unit effort
SSU	special, sensitive, and unique

Acronym	Definition
SURTASS LFA	Surveillance Towed Array Sensor System Low Frequency Active
TBF	to be filed
TCP	Traditional Cultural Property
TSS	total suspended solids
TSHD	trailing suction hopper dredge
TSS	total suspended solids
TTS	temporary threshold shift
UME	unusual mortality event
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
U.S.C.	United States Code
USCG	U.S. Coast Guard

Acronym	Definition
USEPA	U.S. Environmental Protection Agency
VIA	Visual Impact Assessment
Vineyard Wind	Vineyard Wind LLC
VMS	Vessel Monitoring System
VTR	Vessel Trip Report
WDA	Wind Development Area
WEA	Wind Energy Area
WMA	Wildlife Management Area
WTG	wind turbine generator

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1. INTRODUCTION

This Final Environmental Impact Statement (FEIS) assesses the potential environmental, social, economic, historic, and cultural impacts that could result from the construction, operation, maintenance, and eventual decommissioning of the Vineyard Wind 1 Offshore Wind Energy Project (Project) proposed by Vineyard Wind LLC (Vineyard Wind) in its Construction and Operations Plan (COP). The proposed Project is described in the COP and this FEIS and would be approximately 800 megawatts (MW) in scale and sited 14 miles (12 nautical miles) southeast of Martha's Vineyard within Lease Area OCS-A 0501.[1] The Project is designed to serve demand for renewable energy in New England. This FEIS was prepared following the requirements of the National Environmental Policy Act (NEPA; 42 United States Code [U.S.C.] Sections [§§] 4321–4374) and implementing regulations.[2] This FEIS will inform the Bureau of Ocean Energy Management (BOEM) in deciding whether to approve, approve with modifications, or disapprove the COP. This FEIS is not a decision document. After publication of this FEIS, NEPA requires BOEM to wait a minimum of 30 days before issuing a Record of Decision (ROD) that will state BOEM's decision on the COP. This FEIS incorporates the draft analyses presented in the previously published Draft Environmental Impact Statement (DEIS) and Supplement to the Draft EIS (SEIS).

Cooperating agencies may rely on this FEIS to support their decision-making. In conjunction with submitting its COP, Vineyard Wind applied to the National Marine Fisheries Service (NMFS) for an Incidental Take Authorization (ITA) under the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. § 1361 et seq.) for incidental take of marine mammals during Project construction. NMFS is required to review applications and, if appropriate, issue an ITA under the MMPA. In addition, NMFS has an independent responsibility to comply with NEPA, and will rely on the information and analyses in BOEM's EIS to fulfill its NEPA obligations. NMFS intends to adopt the EIS and sign the ROD, if appropriate.[3] The U.S. Army Corps of Engineers (USACE) similarly intends to adopt the EIS and sign the joint ROD in respect to its responsibilities under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899.

1.1. BACKGROUND

BOEM began evaluating Outer Continental Shelf (OCS) wind energy offshore the Commonwealth of Massachusetts (Massachusetts) in 2009 by establishing an intergovernmental renewable energy task force comprised of elected officials from state, local, and tribal governments and affected federal agency representatives. After extensive consultation with the task force, BOEM removed some areas from further consideration for offshore wind leasing to reduce visual impacts, including areas within 12 nautical miles of inhabited land. A detailed list of steps BOEM then took concerning planning and leasing for the OCS offshore of Massachusetts is presented in Appendix C. BOEM held a competitive lease sale under 30 Code of Federal Regulations (C.F.R.) § 585.211 for the lease areas within the Massachusetts Wind Energy Area. Offshore MW LLC (subsequently renamed to Vineyard Wind LLC) won the competition for Lease Area OCS-A 0501 in the auction (Figure 1.1-1). This lease area is 166,886 acres (675 square kilometers [km^2]). In June 2020, Vineyard Wind announced to BOEM that it has secured all the necessary permits for the Covell's Beach landfall location; therefore New Hampshire Avenue is no longer considered.

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[1] For analysis purposes, BOEM assumes in this FEIS that the proposed Project would have an operating period of 30 years. Vineyard Wind's lease with BOEM (Lease Number OCS-A 0501) has an operations period of 25 years that commences on the date of COP approval (see https://www.boem.gov/Lease-OCS-A-0501/ at Addendum B; see also 30 Code of Federal Regulations [C.F.R.] § 585.235(a)(3)). Vineyard Wind would need to request an extension of its operations period from BOEM in order to operate the proposed Project for 30 years. For purposes of the maximum-case scenario and to ensure NEPA coverage if BOEM grants such an extension, however, the FEIS analyzes a 30-year operations period.

[2] On July 16, 2020, the Council on Environmental Quality (CEQ), which is responsible for federal agency implementation of NEPA, updated the regulations for implementing the procedural provisions of NEPA (85 Federal Register [Fed. Reg.] 43304–43376 [July 16, 2020]). Since BOEM's NEPA review of the proposed Project began prior to the September 14, 2020, effective date of the updated regulations, this FEIS was prepared under the previous version of the regulations (1978, as amended in 1986 and 2005). In addition, all 40 C.F.R. references are to the CEQ regulations in effect prior to September 14, 2020.

[3] If NMFS determines the FEIS is sufficient to support its decision under the MMPA.

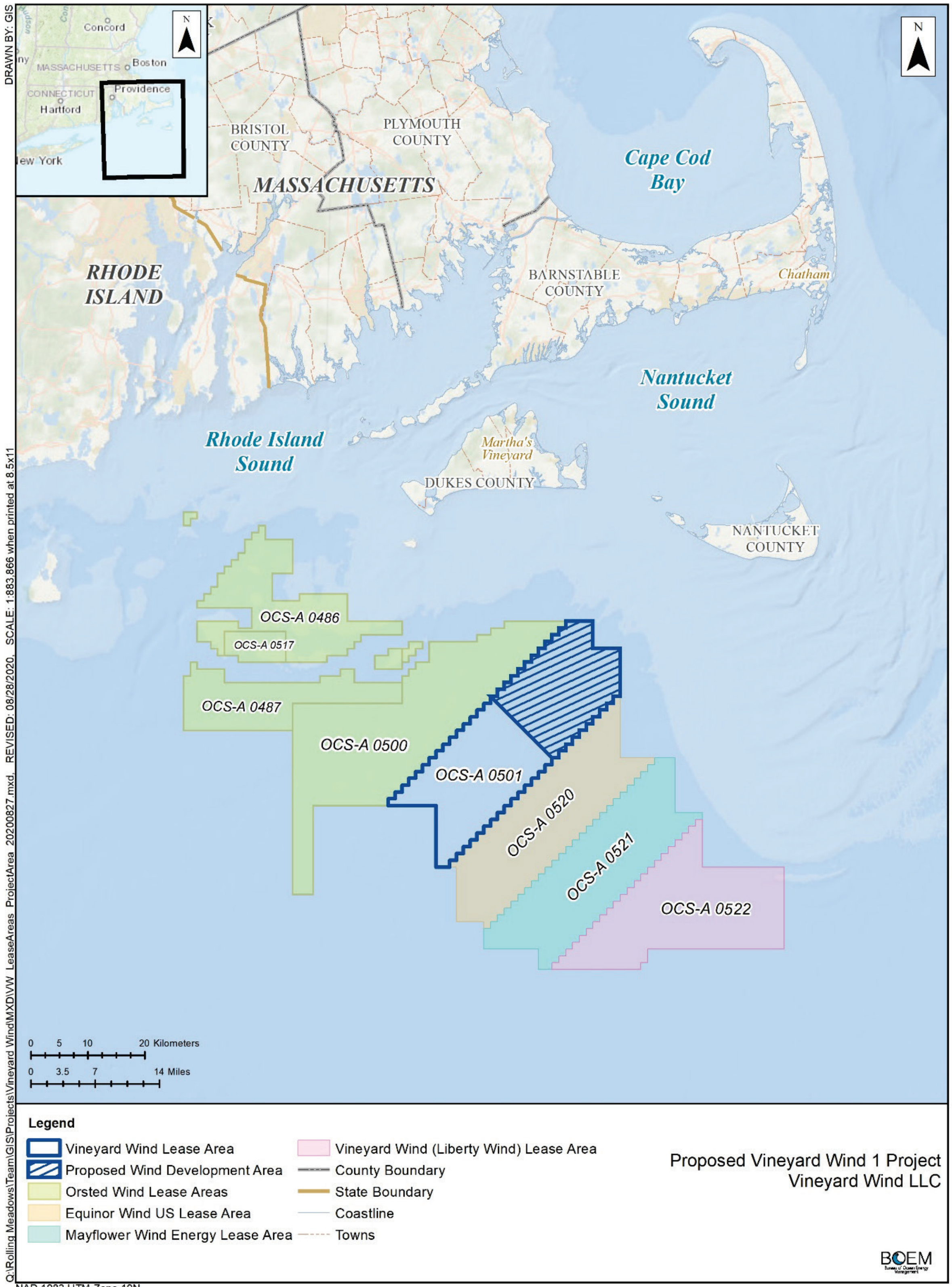


Figure 1.1-1: Proposed Wind Development Area Relative to Rhode Island and Massachusetts Lease Areas

On December 1, 2020, Vineyard Wind withdrew the COP to conduct additional reviews associated with the inclusion of the General Electric Haliade-X wind turbine generator (WTG) into the final Project design. In response to Vineyard Wind's December 1, 2020, letter, BOEM published a Federal Register notice on December 16, 2020, informing the public that "preparation of an Environmental Impact Statement" for the COP was "no longer necessary" for the sole reason that "the COP ha[d] been withdrawn from review and decisionmaking" (85 Federal Register [Fed. Reg.] 81486 [December 16, 2020]). Accordingly, BOEM "terminated" the "preparation and completion" of the EIS. On January 22, 2021, Vineyard Wind notified BOEM via letter that it had completed its review and had concluded that inclusion of the Haliade-X turbines did not warrant any modifications to the COP. Accordingly, Vineyard Wind informed BOEM that it was rescinding its temporary withdrawal and asked BOEM to resume its review of the COP. BOEM confirmed with Vineyard Wind that there were no changes to any of the parameters or conditions submitted with the Vineyard Wind COP. In addition, BOEM conducted an independent review of the information provided by Vineyard Wind, including (but not limited to) technical specifications regarding minimum to maximum individual turbine generation capacity; minimum to maximum tip height; maximum hub height; maximum rotor diameter; tip clearance range above mean lower low water (MLLW) (static and during operations); range, diameter and depth of penetration of the monopole foundations; number of turbines; length of inter-array cables; length, type, diameter, and installation of export cable; turbine transformer size and design; area and volume of scour protection; hammer size for monopile installation; and construction elements and approach. BOEM has confirmed that: (1) the Haliade-X turbines fall within the design envelope analyzed in the June 2020 SEIS; (2) Vineyard Wind's already-submitted COP contains all the necessary information to complete the FEIS; and (3) an additional supplemental EIS is not needed under 40 C.F.R. § 1502.9 because BOEM's selection of the Haliade-X turbine, including the updated technical specifications above, did not modify the proposed action. BOEM has published a Federal Register Notice informing stakeholders that it has resumed the NEPA process.

1.2. PURPOSE AND NEED

Through a competitive leasing process pursuant to 30 C.F.R. § 585.211, Vineyard Wind was awarded Lease Number OCS-A 0501 (Lease) covered a leased area offshore of Massachusetts and the exclusive right to submit a COP for activities within the lease area.[4] Vineyard Wind has submitted a COP proposing the construction, operation, maintenance, and conceptual decommissioning of a commercial-scale, offshore wind energy facility within the area of the Lease. Vineyard Wind provided the most recent updates to this COP on September 30, 2020 (Epsilon 2018a, 2019c, 2020a, 2020b). Vineyard Wind plans to begin construction in 2021.

The purpose of the federal agency action in response to the Vineyard Wind Project COP (Epsilon 2018a, 2019c, 2020a, 2020b) is to determine whether to approve, approve with modifications, or disapprove the COP to construct, operate, and decommission an approximately 800 MW, commercial-scale wind energy facility within the area of the Lease to meet New England's demand for renewable energy. More specifically, the proposed Project would deliver power to the New England energy grid to contribute to Massachusetts's renewable energy requirements—particularly, the Commonwealth's mandate that distribution companies jointly and competitively solicit proposals for offshore wind energy generation (220 Code of Massachusetts Regulations § 23.04(5)). BOEM's decision on Vineyard Wind's COP is needed to execute its duty to approve, approve with modifications, or disapprove the proposed Project in furtherance of the United States' policy to make OCS energy resources available for expeditious and orderly development, subject to environmental safeguards (43 U.S.C. § 1332(3)), including consideration of natural resources and existing ocean uses.

[4] Lessees may request to assign a portion of their lease to another qualified legal entity. See Appendix A for additional information.

1.3. Regulatory Framework

The Energy Policy Act of 2005, Public Law 109-58, added section 8(p)(1)(c) to the Outer Continental Shelf Lands Act (OCSLA; 43 U.S.C. § 1337(p)(1)(c)[5]. The new section authorized the Secretary of Interior to issue leases, easements, and rights-of-way (ROWs) in the OCS for renewable energy development, including wind energy. The Secretary delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing the authority for renewable energy leasing under OCSLA (30 C.F.R. Part 585) were promulgated on April 22, 2009[6]. These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove Vineyard Wind's COP (30 C.F.R. § 585.628).

Consistent with the requirements of OCSLA and applicable regulations, Section 2 of BOEM's lease form provides the Lessee with the 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 C.F.R. Part 585; 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 U.S.C. § 1337(p)(4), or for other reasons provided by BOEM pursuant to § 585.613(e)(2) or § 585.628(f); BOEM reserves the right to approve a COP with modifications; and BOEM reserves the right to authorize other uses within the leased area and project easement that will not unreasonably interfere with activities described in an approved COP pursuant to the lease.

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 U.S.C. § 1531-1544). The analyses in this FEIS will inform BOEM's decision under 30 C.F.R. § 585.628 for the COP that was initially submitted to BOEM in December 2018 and later updated with new information. Vineyard Wind recently submitted a COP for the remaining southern portion of area of the Lease that is in the initial stages of BOEM's review and approval process.

The Revised Massachusetts Environmental Assessment (BOEM 2014b) gives a more comprehensive description of BOEM's regulatory authority and decision-making process and is incorporated by reference in Chapter 3 where appropriate. 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. Appendix C provides a description of BOEM's consultation efforts in the development of this FEIS.

Table 1.3-1 in Appendix B[7] outlines the federal, state, regional, and local permits and authorizations required for all action alternatives and provides the status of each. Consultations are addressed in Appendix C.

1.4. Relevant Existing NEPA and Consulting Documents

BOEM previously prepared the following NEPA and consulting documents, which BOEM used to inform preparation of this FEIS and which have been incorporated by reference where appropriate. Additional, non-NEPA documents related to environmental studies performed in Massachusetts to support decisions concerning offshore wind energy development are available on BOEM's website.[8]

- *Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf—Final Environmental Impact Statement, October 2007* (MMS 2007a)
- *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts—Revised Environmental Assessment*, May 2013 (BOEM 2013)
- *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts—Revised Environmental Assessment,* June 2014 (BOEM 2014b)
- *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New York—Revised Environmental Assessment,* June 2016 (BOEM 2016)

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

[6] Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf, 74 Fed. Reg. 19638–19871 (April 29, 2009)

[7] Unless otherwise specified, all tables referenced in this chapter are in Appendix B.

[8] https://www.boem.gov/Massachusetts-Environmental-Studies/

1.5. The Facility Design Report and Fabrication and Installation Report

If the COP is approved, Vineyard Wind must then submit a Facility Design Report (FDR) and a Fabrication and Installation Report. The FDR provides specific engineering details of the design of all facilities, including structural drawings, environmental and engineering data, a complete set of calculations used for design, Project-specific geotechnical studies, and a description of loads imposed on the facility. The FDR must demonstrate that the design conforms to the responsibilities under the lease. The Fabrication and Installation Report describes how the facilities would be fabricated and installed in accordance with the design criteria identified in the FDR, the COP, and generally accepted industry standards and practices. Both of these reports must be reviewed and certified by a BOEM-approved, third-party Certified Verification Agent before submittal. BOEM has 60 days to review these reports and provide objections to Vineyard Wind. If BOEM has no objections to the reports—or once any BOEM objections have been resolved—Vineyard Wind may commence construction of the proposed Project.

1.6. Methodology for Assessing the Project Design Envelope

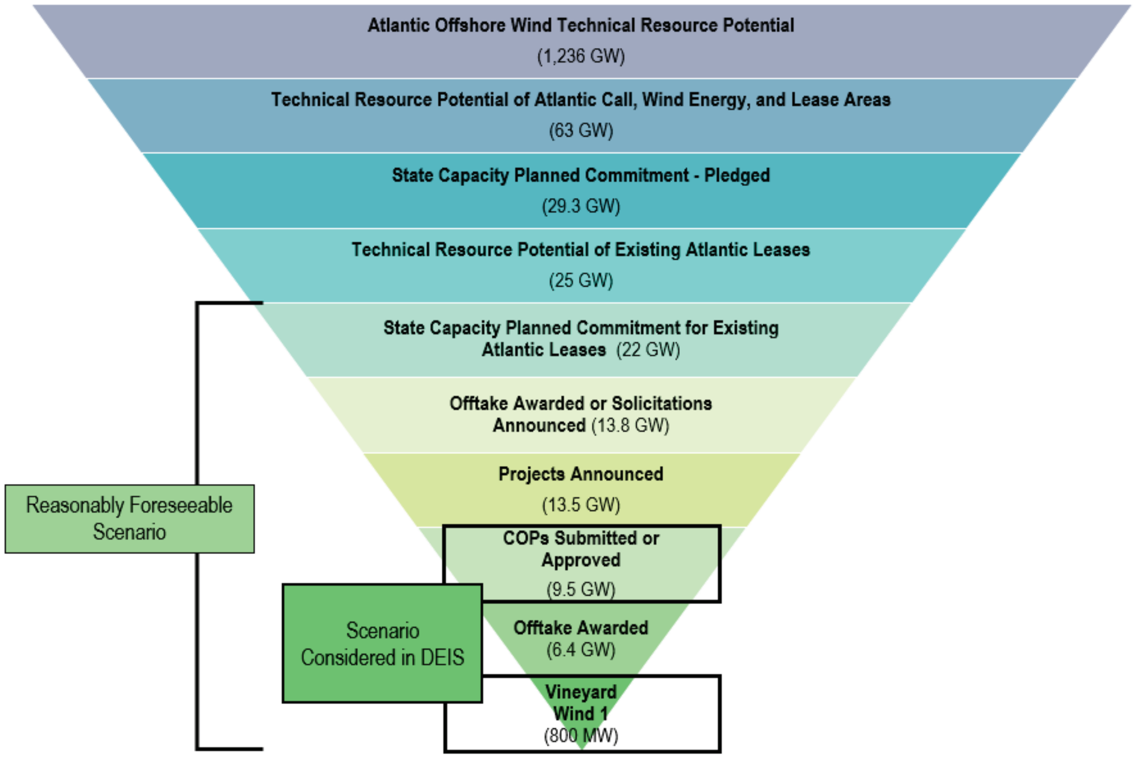
Vineyard Wind would implement a Project Design Envelope (PDE) concept. This concept allows Vineyard Wind to define and bracket proposed Project characteristics for environmental review and permitting while maintaining a reasonable degree of flexibility for selection and purchase of Project components such as WTGs, foundations, submarine cables, and offshore substations.[9] Appendix G explains in more detail the PDE approach and presents a detailed table outlining the most impacting design parameters by resource area.

1.7. Methodology for Assessing Planned Action Impacts

1.7.1. Overview of the Scope for Offshore Wind Activities

BOEM analyzed the possible extent of future offshore wind development in the United States on the Atlantic OCS to determine reasonably foreseeable effects measured by installed power capacity, and the SEIS was published in June 2020 (BOEM 2020c). This is summarized in Figure 1.7-1 and expands what offshore wind actions are considered reasonably foreseeable beyond those included in the DEIS to include approximately 22 gigawatts (GW) of offshore wind power projects. Table 1.7-1 includes the Atlantic offshore wind commitments by state which is divided among awarded, scheduled, and planned but unscheduled procurements. Table 1.7-2 describes the current approved, proposed, and contemplated projects across all Atlantic lease areas. The methodology for assessing planned action impacts is described in detail in Appendix A.

[9] Additional information and guidance related to the PDE concept can be found at https://www.boem.gov/Draft-Design-Envelope-Guidance/.



Note: Each category or level includes the entirety of the levels below it. Further, these categories are not mutually exclusive and some of them include projects that fall under other categories (e.g., the Technical Resource Potential of Existing Atlantic Leases also includes the Vineyard Project).

Figure 1.7-1: Scope for Future Possible Development of Offshore Wind

The quantitative planned action analysis in the DEIS only considered as reasonably foreseeable those proposed offshore wind projects with COPs submitted or approved at the time of analysis. Including the Proposed Action, this consisted of the Tier 1 and Tier 2 projects described in Appendix C of the DEIS totaling 926 MW. No other offshore wind projects were considered reasonably foreseeable in the DEIS; however, the planned action impacts of Tier 3 projects were incorporated into the DEIS based on information available. BOEM considered the scope of the analysis in the DEIS to be NEPA-compliant. Considering that wind energy is a growing industry, BOEM decided to expand its planned action analysis and has concluded that approximately 22 GW[10] of Atlantic offshore wind development is reasonably foreseeable, which encompasses the following potential development described in the June 2020 SEIS (with the MWs of power in parentheses including both the item and all items above it):

- Vineyard Wind 1 Project (800 MW).
- All projects with power offtake[11] awarded (with the exception of Bay State Wind[12]), which includes all of the projects listed in the previous criteria as well as Mayflower Wind (6.4 GW).
- All projects with COPs approved or submitted (in addition to the proposed Project), which includes South Fork Wind, Bay State Wind, Skipjack Wind, Ocean Wind, Coastal Virginia Offshore Wind, Vineyard Wind 2 (also referred to as Park City Wind), Sunrise Wind, Revolution Wind, US Wind, and Empire Wind) (9.5 GW).
- All projects for which the developer has publicly announced development plans, regardless of whether a COP has been approved or submitted or offtake awarded (in addition to the projects identified in the previous criteria), which includes Liberty Wind and Dominion Energy (13.5 GW).

[10] The existing lease areas are sufficient to support development of 22 GW of offshore wind.

[11] "Offtake" in this document is defined as the offshore wind energy produced and delivered to shore for use by purchasers.

[12] Bay State Wind submitted a COP, but currently has no offtake awarded for the project.

- All announced and scheduled state offtake solicitations, whether or not they are linked to plans or arrangements with particular developers. With the exception of Dominion Energy, this includes all of the projects identified in the previous criterion, as well as the additional development necessary to fulfill the remaining announced offshore wind solicitations (distinct from announced state goals, 2,534 MW[13] beyond what is currently represented by submitted or announced COPs). The development considered here is geographically sensitive and assumes that state interest levels do not shift (13.8 GW).
- The remaining planned but unscheduled Atlantic state solicitations for existing lease areas (Massachusetts and Virginia) (22 GW).[14] There are no submitted COPs for some of the actions considered reasonably foreseeable in this scenario. However, this information is not essential to a reasoned choice among alternatives.

1.7.2. Incorporation by Reference of the 2019 BOEM Study of Impact-Producing Factors

BOEM has completed a study of impact-producing factors (IPFs) on the North Atlantic OCS to consider in an offshore wind development planned action scenario (BOEM 2019b). That study is incorporated in this FEIS by reference. The study identifies cause-and-effect relationships between renewable energy projects and resources potentially affected by such projects. It classifies those relationships into a manageable number of IPFs through which renewable energy projects could affect resources. It also identifies the types of actions and activities to be considered in a planned action scenario. The study 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. Table 1.7-3 provides a brief description of the primary IPFs involved in this analysis, some including multiple sub-IPFs. The IPFs are used in the impacts analysis and are project-specific in the text when applicable. See Table 1.7-3 for more detailed definitions used in the 2019 study.

The BOEM (2019a) study identifies the relationships between IPFs associated with specific past, present, and reasonably foreseeable actions and activities in the North Atlantic OCS to consider in a NEPA planned action scenario. These IPFs and their relationships were used in the SEIS analysis of the planned action scenario and BOEM decided which IPFs applied to which resources. If an IPF was not associated with the Vineyard Wind 1 Project, it was not included in the expanded planned action analysis. The one exception to this was the inclusion of Climate Change IPFs. This FEIS identifies specific actions and activities in Appendix A.

As discussed in the BOEM (2019a) study and the DEIS and SEIS, reasonably foreseeable planned actions other than offshore wind projects may also affect the same resources as the proposed Project or other offshore wind projects, possibly via the same IPFs or via IPFs through which offshore wind projects do not contribute. Appendix A lists reasonably foreseeable environmental trends and planned actions for non-offshore wind activities that may contribute to the impacts of the proposed Project. Refer to Appendix A for details.

[13] A total of 7,308 MW of procurements have been announced, and 4,240 MW of available capacity identified in submitted or announced COPs. Some states have goals beyond announced procurements. The ability for a project to fulfill a particular procurement is geographically sensitive. Maryland and New Jersey each have announced procurements for which there are currently no nearby announced or submitted COPs with available capacity, though leased areas without an associated COP are available. If New York announces additional procurements towards its state goal, both New York and New Jersey will have more announced procurements than available lease capacity within the New York Bight.

[14] Approximately 4.7 GW of planned solicitations for the state of New York are not included because BOEM considers them reliant on additional leasing in the New York Bight. Approximately 4 GW of offshore wind goals for the state of New Jersey are not included as BOEM considers them reliant on additional leasing in the New York Bight.

1.7.3. Resource Geographic Analysis Area

Each resource has a geographic area in which effects of the proposed Project would be felt. Appendix A describes and provides a figure for the geographic analysis area of each resource; identifies reasonably foreseeable wind energy projects and other activities in addition to the proposed Project that are or could be located within the geographic analysis areas depicted; and includes a reasonably foreseeable environmental trends and planned actions impact scenario for each resource considering impacts from these projects and activities collectively.[15]

[15] These resource-specific geographic analysis areas are largely the same as presented in the DEIS (Appendix A gives reasons for the few that have been revised).

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1. OVERVIEW OF ALTERNATIVES

This chapter describes the six action alternatives (one of which has two sub-alternatives) and the No Action Alternative for the proposed Project analyzed in detail (Table 2.1-1) and provides details and assumptions for each to assess potential impacts.[1] The SEIS added a Vessel Transit Lane Alternative, Alternative F, which is carried forward to this FEIS. In addition, Vineyard Wind has modified the proposed Project since publication of the DEIS. The Proposed Action and action alternatives below incorporate these changes and the FEIS analyses their effects to the extent they are relevant, although these summary descriptions of each individual alternative are the same as provided in the DEIS. This chapter also describes BOEM's Preferred Alternative. Additionally, Section C.5 in Appendix C discusses action alternatives that were considered but not analyzed in detail.

Table 2.1-1: Alternatives Considered for Analysis

Alternative	Description
Alternative A—Proposed Action	Under Alternative A, the Proposed Action, the construction, operation, maintenance, and eventual decommissioning of an up to 800 MW wind energy facility on the OCS offshore Massachusetts within the proposed Project area and associated export cables would occur within the range of design parameters outlined in the Vineyard Wind COP (Epsilon 2018a, 2019a, 2019c, 2020a, 2020b), subject to applicable mitigation measures.
Alternative B—Covell's Beach Cable Landfall Alternative[2]	Under Alternative B, the Covell's Beach Cable Landfall Alternative, the construction, operation, maintenance, and eventual decommissioning of an up to 800 MW wind energy facility on the OCS offshore Massachusetts within the proposed Project area and associated export cables would occur within the range of the design parameters outlined in the Vineyard Wind COP, subject to applicable mitigation measures. However, the New Hampshire Avenue landfall location option presented in the COP would not be used and the cable landfall would be limited to Covell's Beach to potentially reduce impacts on environmental and socioeconomic resources.
Alternative C—No Surface Occupancy in the Northernmost Portion of the Project Area Alternative	Under Alternative C, the No Surface Occupancy in the Northernmost Portion of the Project Area Alternative, the construction, operation, maintenance, and eventual decommissioning of an up to 800 MW wind energy facility on the OCS offshore Massachusetts within the proposed Project area and associated export cables would occur within the range of the design parameters outlined in the Vineyard Wind COP, subject to applicable mitigation measures. However, no surface occupancy would occur in the northernmost portion of the proposed Project area to potentially reduce the visual impacts of the proposed Project and potential conflicts with existing ocean uses, such as marine navigation and commercial fishing. This alternative would result in the exclusion of approximately six of the northernmost WTG locations.
Alternative D—Wind Turbine Layout Modification Alternative	Under Alternative D, the Wind Turbine Layout Modification Alternative, the construction, operation, maintenance, and eventual decommissioning of an up to 800 MW wind energy facility on the OCS offshore Massachusetts within the Vineyard Wind lease area and associated export cables would occur within the range of the design parameters outlined in the Vineyard Wind COP, subject to applicable mitigation measures. However, modifications would be made to the wind turbine array layout to potentially reduce impacts on existing ocean uses, such as commercial fishing and marine navigation. Each of the below sub-alternatives may be individually selected or combined with any or all other alternatives or sub-alternatives.

[1] The assumptions and maps for all action alternatives other than the Proposed Action do not represent specific proposals and are provided only for context and illustration about what these alternatives could look like if implemented. If BOEM selects one or more alternatives that are not the Proposed Action, the layouts constructed could vary with diverse considerations such as engineering, presence of cultural or historic resources, or seabed hazards. Chapter 3 and Appendix A addresses the potential implications of these variations and additional survey work that may be necessary.

[2] The DEIS and SEIS contemplated two Onshore Export Cable Routes (OECRs), with alternative options within each route; however, since the publication of the SEIS, Vineyard Wind has stated all necessary state and local permits for the Covell's Beach landfall location have been acquired. Therefore, the Proposed Action (Alternative A) and action alternatives only contemplate the Covell's Beach landfall and onshore route, and Alternative B is no longer evaluated as an action alternative in this FEIS. The identification of the action alternatives will maintain the same lettering (Vineyard Wind 2020d).

Alternative	Description
Alternative D1—One-Nautical-Mile Wind Turbine Spacing Alternative	Under Alternative D1, WTGs would have a minimum spacing of 1 nautical mile between them, and the lanes between turbines would also be a minimum of 1 nautical mile to potentially reduce conflicts with existing ocean uses, such as commercial fishing and marine navigation.
Alternative D2—East-West and One-Nautical-Mile Wind Turbine Layout Alternative	Under Alternative D2,[3] the wind turbine layout would be arranged in an east-west orientation and all WTGs in the east-west direction would have a minimum spacing of 1 nautical mile between them to allow for vessels to travel in an unobstructed path between rows of turbines in an east-west direction. This alternative would potentially reduce conflicts with existing ocean uses, such as commercial fishing, by facilitating the established practice of mobile and fixed-gear fishing practices and vessels fishing in an east-west direction.
Alternative E—Reduced Project Size Alternative	Under Alternative E, the Reduced Project Size Alternative, the construction, operation, maintenance, and eventual decommissioning of a large-scale commercial wind energy facility on the OCS offshore Massachusetts within the proposed Project area and associated export cables would occur within the range of the design parameters outlined in the Vineyard Wind COP, subject to applicable mitigation measures, with the following exception: the proposed Project would consist of no more than 84 WTGs in order to potentially reduce impacts on existing ocean uses and environmental resources.
Alternative F—Vessel Transit Lane Alternative	Under Alternative F, a vessel transit lane through the WDA would be established in which no surface occupancy would occur. The lane included in this alternative, and not included in other alternatives, could potentially facilitate transit of vessels through the Project area from southern New England ports—primarily New Bedford—to fishing areas on Georges Bank. WTG locations displaced by the transit lane would not be eliminated from consideration, but are assumed to move the proposed Project south of the WDA within the existing Vineyard Wind lease area. This alternative will disclose the effect a transit lane could have on the expected effects from the other action alternatives analyzed in this FEIS.
Alternative G—No Action Alternative	Under Alternative G, the No Action Alternative, the proposed Project and associated activities as described in the Vineyard Wind COP would not be approved and the proposed construction, operation, maintenance, and decommissioning activities would not occur. Any potential environmental and socioeconomic costs and benefits associated with the proposed Project as described under Alternative A, the Proposed Action, would not occur.

COP = Construction and Operations Plan; EIS = Environmental Impact Statement; MW = megawatt; OCS = Outer Continental Shelf; WDA = Wind Development Area; WTG = wind turbine generator

These alternatives were developed using screening criteria for determining a range of reasonable alternatives, extensive coordination with state and federal agencies, and input from the public and potentially affected stakeholders through the DEIS scoping process and comment period (Appendix C). The alternatives summarized above and analyzed in this FEIS support the purpose and need for the EIS, are relevant to BOEM's decision, and are implementable and technically feasible.

The alternatives listed in Table 2.1-1 are not mutually exclusive. If the COP is approved or approved with modifications, BOEM could "mix and match" multiple listed alternatives to result in a preferred alternative so long as crucial design parameters are compatible and otherwise meet the purpose and need of the Proposed Action. For example, BOEM could select a combination of alternatives for the proposed Project with the northernmost wind turbines relocated to the southern Wind Development Area (WDA) and east-west orientation and 1-nautical-mile wind turbine layout (i.e., Alternatives C and D2).

[3] Small variances throughout a wind farm should not significantly affect safety of navigation. The 2020 Final Massachusetts and Rhode Island Port Access Route Study (MARIPARS; USCG 2020b: https://www.federalregister.gov/documents/2020/01/29/2020-01522/port-access-route-study-the-areas-offshore-of-massachusetts-and-rhode-island) provided quantitatively derived recommendations for turbine spacing and transit lane widths within the wind arrays. For an array developed in a uniform grid, aligned along cardinal headings with 1-nautical-mile spacing, the diagonal lanes would be approximately 0.7 nautical mile wide. The Final MARIPARS concluded that "(1) lanes for vessel transit should be oriented in a northwest to southeast direction, 0.6 NM [nautical miles] to 0.8 NM wide. This width will allow vessels the ability to maneuver in accordance with the COLREGS [International Regulations for Preventing Collisions at Sea] while transiting through the RI/MA WEA [Rhode Island/Massachusetts Wind Energy Area]; (2) lanes for commercial fishing vessels actively engaged in fishing should be oriented in an east to west direction, 1 NM nautical mile wide; and (3) lanes for USCG search and rescue operations should be oriented in a north to south and east to west direction, 1 NM wide. This will ensure two lines of orientation for USCG helicopters to conduct SAR operations" (USCG 2020b).

BOEM considers those measures that Vineyard Wind has committed to in its COP to be part of the Proposed Action and action alternatives. The alternatives listed in Table 2.1-1 do not include potential additional mitigation measures that are analyzed separately in this FEIS (Section 2.2.1). BOEM, in consultation with cooperating agencies, may select any of the mitigation measures identified and assessed in this FEIS in addition to the alternative or combination of alternatives it selects in the ROD, and may select additional measures arising from ongoing cooperating agency consultation or during review of the COP. Additionally, compliance with applicable laws and regulations by Vineyard Wind and BOEM may require additional measures or changes to the measures described in this FEIS. This FEIS analyses measures identified to date from consultation with cooperating agencies, but additional or modified measures may arise before consultation is completed—for example consultation under the MMPA or the Magnuson-Stevens Fishery Conservation and Management Act (MSA).[4] Measures considered in this FEIS are listed in Appendix D. Any measures that are required as conditions of COP approval would be incorporated and documented in the ROD.

2.1.1. Proposed Action (Alternative A)

Alternative A, the Proposed Action, would allow Vineyard Wind to construct, operate, maintain, and eventually decommission a wind energy facility approximately 800 MW in scale on the OCS offshore Massachusetts within Vineyard Wind's WDA, along with associated export cables. As discussed in Chapter 1, Vineyard Wind has submitted a COP describing its Proposed Action, which is summarized below. The Proposed Action does not include additional mitigation measures that BOEM is analyzing and could implement as part of its approval process (Section 2.2.1 and Appendix D). Vineyard Wind would undertake the Proposed Action within the PDE summarized in Appendix G, Table G-1.[5] Additional details of the Proposed Action are contained in COP Volume I (Epsilon 2020a). Since publication of the DEIS, Vineyard Wind has submitted a modified COP with minor changes to the PDE to allow for the possibility of using WTGs of higher capacity. The SEIS and this FEIS analyze the changes to the COP where relevant and update the maximum-case scenario where necessary (Epsilon 2020a).[6] The proposed Project could use higher nameplate capacity WTGs, up to 14 MW (Table 2.1-2). As shown in Appendix G, Figure G-1, the General Electric Haliade-X WTG, which would be designed specifically for the proposed Project, would fit within the parameters of the Vineyard Wind PDE presented in the COP [7]. Depending on the turbine capacity used, the proposed Project could involve as few as 57 WTGs or as many as 100 WTGs. Vineyard Wind has not changed the lower limit of WTG capacity in the PDE; thus, the Project could still utilize up to 100 WTGs as evaluated in the DEIS. The changes were presented in the SEIS and are incorporated below as well as in Chapter 3. Table 2.1-2 details the changes to the limits of the PDE, and Appendix E of this FEIS provides additional information as an update to the DEIS Appendix G. As evaluated in the SEIS and in Chapter 3 and Appendix A of this FEIS, use of fewer, larger turbines could have less impact on many resources, such as benthic resources, marine mammals, and sea turtles, because of decreased pile-driving activities. However, larger turbines could have greater visual impacts, and positive economic effects could be less with fewer turbines than with a greater number of smaller turbines.

[4] Appendix C provides the latest information related to BOEM's consultation and coordination with cooperating agencies.

[5] See Section 1.6 and Appendix G for additional design envelope information.

[6] The most recent version of the COP is available at https://www.boem.gov/Vineyard-Wind/.

[7] On December 1, 2020, Vineyard Wind withdrew the COP to conduct additional reviews associated with the inclusion of the General Electric Haliade-X WTG into the final project design. In response to Vineyard Wind's December 1, 2020, letter, BOEM published a Federal Register Notice on December 16, 2020, informing the public that "preparation of an Environmental Impact Statement" for the COP was "no longer necessary" for the sole reason that "the COP ha[d] been withdrawn from review and decisionmaking" (85 Fed. Reg. 81486 [December 16, 2020]). Accordingly, BOEM "terminated" the "preparation and completion" of the EIS. On January 22, 2021, Vineyard Wind notified BOEM via letter that it had completed its review and had concluded that inclusion of the Haliade-X turbines did not warrant any modifications to the COP. Accordingly, Vineyard Wind informed BOEM that it was rescinding its temporary withdrawal and asked BOEM to resume its review of the COP. After conducting an independent review of the information provided by Vineyard Wind, BOEM has confirmed that: (1) the Haliade-X turbines fall within the design envelope analyzed in the June 2020 SEIS; (2) Vineyard Wind's already-submitted COP contains all the necessary information to complete the FEIS; and (3) an additional SEIS is not needed under 40 C.F.R. § 1502.9. BOEM will publish a Federal Register Notice informing stakeholders that it has resumed the NEPA process.

Table 2.1-2: Changes to the Limits of the Proposed Project Design Envelope

Envelope Parameter	Previous Limit	Current Limit
Total Number of Turbines	Up to 100	57 to 100
Total Facility Capacity	~800 MW [a]	~800 MW [a]
Maximum Turbine Generation Capacity	10 MW	14 MW
Maximum Tip Height	696 feet (212 meters) MLLW [b]	837 feet (255 meters) MLLW [b]
Maximum Hub Height	397 feet (121 meters) MLLW [b]	473 feet (144 meters) MLLW [b]
Maximum Rotor Diameter	591 feet (180 meters) MLLW [b]	729 feet (222 meters) MLLW [b]
Maximum Tip Clearance	102 feet (31 meters) MLLW [b]	105 feet (32 meters) MLLW [b]
Substation Footprint	6.4 acres (25,899.9 m^2)	8.6 acres (34,803.1 m^2)

m^2 = square meters; MLLW = above mean lower low water; MW = megawatt
[a] Vineyard Wind's Proposed Action is for an 800 MW offshore wind energy project. This FEIS evaluates the potential impacts of a facility up to 800 MW to ensure that it covers projects constructed with a smaller capacity.
[b] Elevations relative to mean higher high water are approximately 3 feet (1 meter) lower than those relative to MLLW.

2.1.1.1. Construction and Installation

The Proposed Action would include the construction and installation of both onshore and offshore facilities. Construction and installation are expected to begin in the first quarter of 2021 and be completed by the second quarter of 2024. Vineyard Wind submitted an updated construction schedule to BOEM in January 2021 (Vineyard Wind 2021a). The following is expected: construction of the Onshore Export Cable Route (OECR) would begin in first quarter 2021; construction of the onshore substation would begin in third quarter 2021; construction within the Offshore Export Cable Corridor (OECC) would begin in second quarter 2022; turbine and ESP installation and the electrical service platform (ESP) would begin second quarter 2023; and inter-array cable installation would begin in third quarter 2023.

2.1.1.1.1. Onshore Activities and Facilities

Proposed onshore Project elements include the landfall site, the onshore export cables from the landfall site to the onshore substation, the onshore substation site, and the connection from the proposed substation site to the existing bulk power grid (Figure 2.1-1).

The DEIS and SEIS contemplated two OECRs, with alternative options within each route; however, since the publication of the SEIS, Vineyard Wind has stated that all necessary state and local permits for the Covell's Beach landfall location have been acquired. Therefore, the Proposed Action now only contemplates Covell's Beach landfall and onshore route. Most of the proposed OECR would pass through already developed areas, primarily paved roads, and existing utility ROWs and would be entirely underground. The OECR would run for 5.3 miles (8.5 kilometers) until it reached the proposed substation site discussed below. Figure 2.1-1 shows the proposed landfall location. The Covell's Beach landfall site is located on Craigville Beach Road in the Town of Barnstable near a paved parking lot entrance to a public beach that is owned and managed by the Town of Barnstable. The transition of the export cables from offshore to onshore would be accomplished by horizontal directional drilling (HDD), which would bring the proposed cables beneath the nearshore area, the tidal zone, beach, and adjoining coastal areas to the proposed landfall site. As part of the HDD process, the seafloor would be temporarily affected at the HDD exit point where a shallow 10 x 10 foot (3 x 3 meter) pit would be excavated to expose the conduit end. This temporary receiving pit would be filled back in with the same material once the submarine cable has been brought to land (COP Addendum, Sections 1.2.2.2 and 1.3; Epsilon 2019a).

Vineyard Wind would construct one or more underground concrete transition vaults, also called splice vaults, at the landfall site. These would be accessible after construction via a manhole. Inside the splice vault(s), the 220-kilovolt (kV) alternating current (AC) offshore export cables would be connected to the 220 kV onshore export cables.

Vineyard Wind would run the onshore export cables through a single concrete duct bank buried along the entire OECR. The duct bank may vary in size along its length, and the planned duct bank could be arrayed four conduits wide by two conduits deep (flat layout) measuring up to 5 feet (1.5 meters) wide by 2.5 feet (0.8 meter) deep or vice versa with an upright layout with two conduits wide by four conduits deep. The top of the duct bank would typically have a minimum of 3 feet (0.9 meter) of cover comprised of properly compacted sand topped by pavement.

Figure 2.1-1: Proposed Landfall Site

The proposed onshore export cables would terminate at the proposed substation site. This previously developed site is adjacent to an existing substation within Independence Park, a commercial/industrial area in Barnstable. The new onshore substation site would have an area of 8.6 acres (34,803.1 square meters [m^2]). As specified in the SEIS, Vineyard Wind has proposed an expansion of the proposed onshore substation since the DEIS was published (Table 2.1-2). For the expanded substation area, the total approximate area of ground disturbance would be 7.7 acres (31,161 m^2), or 1.8 acres (7,122 m^2) greater than the 5.9 acres (23,877 m^2) assumed in the DEIS. The majority of ground disturbance would occur in previously disturbed (paved) areas where no tree clearing would be needed (potentially 0.2 acre [809 m^2] may require tree clearing).

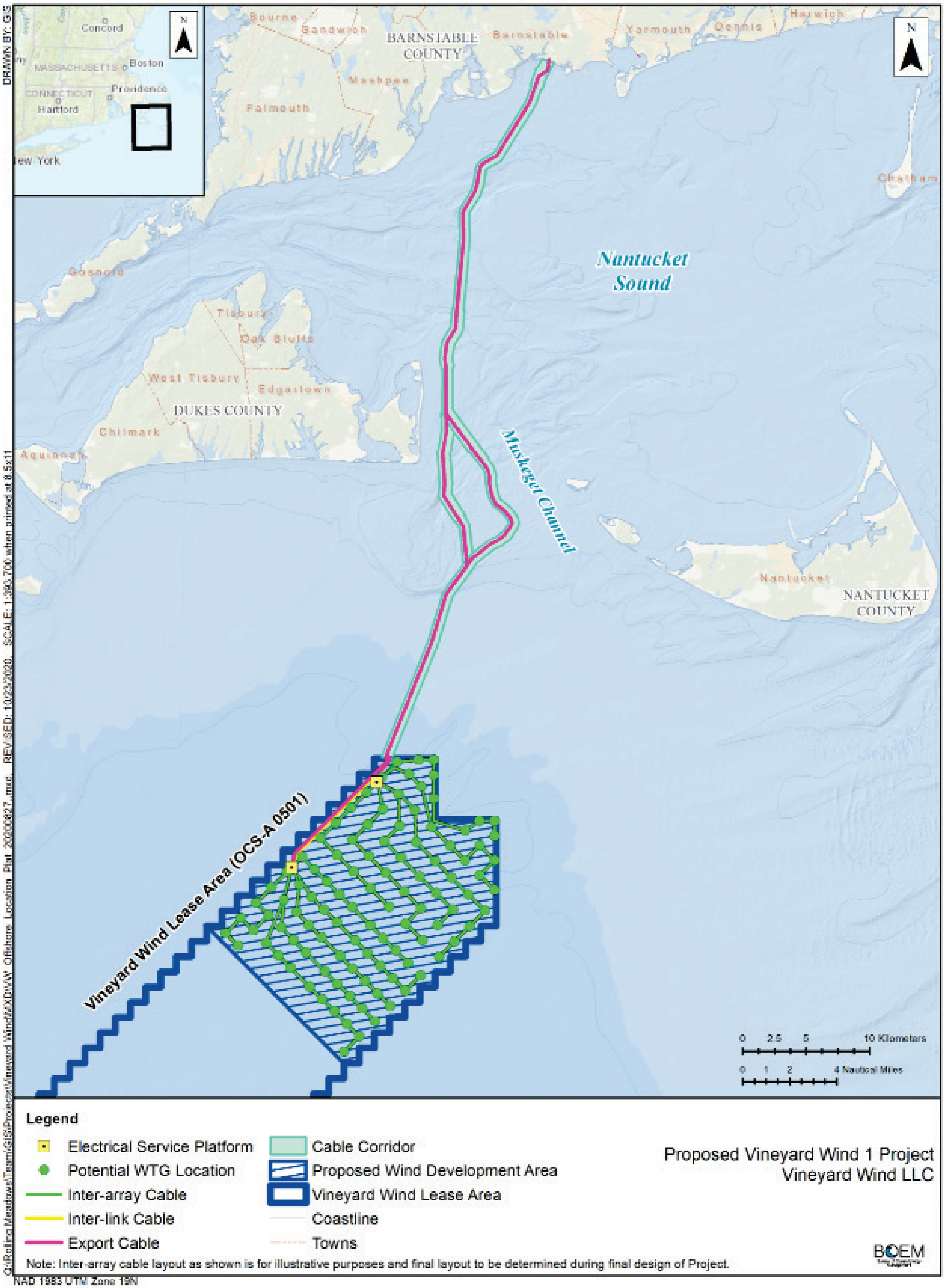
The southern portion of the expanded substation area is wooded, and an additional 0.2 acre [809 m^2] may need to be cleared, for a total of 6.1 acres (24,686 m^2) of tree clearing. This 6.1 acres (24,686 m^2) of tree clearing is within the estimated 7 acres (28,328 m^2) of tree clearing analyzed in the DEIS. BOEM analyzed the impacts of this change to the proposed Project under the appropriate resource area sections within SEIS and within this FEIS. The buried duct bank would enter the proposed onshore substation site via an access road that provides access to the transmission corridor from Mary Dunn Road. The onshore substation site would connect the proposed Project to the existing bulk power grid via step-down transformers. Vineyard Wind plans to connect the proposed Project to the grid via available positions at the Barnstable Switching Station, just north of the proposed onshore substation site (Figure 2.1-1). Onshore construction and installation activities and associated equipment would involve fuel and lubricating and hydraulic oils.

2.1.1.1.2. Offshore Activities and Facilities

Proposed offshore Project components include WTGs and their foundations, ESPs and their foundations, scour protection for all foundations, inter-array cables that connect the WTGs to the ESPs, the inter-link cables that connect the ESPs, and the export cables to the landfall location (Figure 2.1-2). The proposed offshore Project elements are located within federal waters, with the exception of a portion of the export cables located within state waters. COP Section 4.2.3 provides a detailed description of proposed construction and installation methods (Volume I; Epsilon 2020a).

Vineyard Wind proposes the installation of up to 100 WTGs of 8 to 14 MW capacity, with blades extending up to 837 feet (255 meters) above mean lower low water (MLLW) with an average spacing between WTGs of approximately 0.86 nautical mile within the 75,614-acre (306 km^2) WDA.[8] Under Alternative A, Vineyard Wind's proposed WTG layout includes one demarcated northwest/southeast corridor and one demarcated northeast/southwest corridor, each 1 nautical mile wide. The sum of seafloor areas disturbed by construction and areas of seafloor occupied by foundations and protections would cover approximately 0.5 percent of the WDA. Vineyard Wind would mount the WTGs on either monopile or jacket foundations. A monopile is a long steel tube driven 66 to 148 feet (20 to 45 meters) into the seabed. A jacket foundation is a latticed steel frame with three or four supporting piles driven 98 to 197 feet (30 to 60 meters) into the seabed (or as far as 246 feet [75 meters] in the case of jackets for ESP foundations). Vineyard Wind would likely install jacket foundations in deeper WTG locations. Vineyard Wind's PDE includes up to 12 jacket foundations for the proposed Project (up to 10 jackets for WTG foundations and up to 2 jackets for ESP foundations).

[8] The minimum distance between nearest turbines is no less than 0.65 nautical mile and the maximum distance between nearest turbines is no more than 1.1 nautical miles (COP Section 3.1.1.1, Volume I; Epsilon 2020a).



Note: The inter-array cable layout shown is an example, and the final layout and location of the cables would be located within the approved PDE.

Figure 2.1-2: Proposed Offshore Project Elements

Schematic drawings and photos of the proposed foundation types are included in COP Volume I, Section 3.1.2 (Epsilon 2020a). Each WTG would contain approximately 1,717 gallons (6,500 liters) of transformer oil, approximately 2,113.4 gallons (8,000 liters) of general oil (for hydraulics and gearboxes), and approximately 792 gallons (3,000 liters) of diesel fuel. Use of other chemicals would include, coolants/refrigerants, grease, paints, and sulfur hexafluoride. While anti-fouling paint is not necessary on most parts of the WTG and ESP foundations, anti-fouling paint may be used at each foundation in the immediate area of the opening for the cable pull-in (within an approximately 4-foot-diameter [1.2-meter] circle centered on the opening for the cable). COP Section 4.2 provides additional details related to proposed chemicals and their anticipated volumes (Volume I; Epsilon 2020a).[9]

Vineyard Wind would construct one or two ESPs in the WDA, each installed on a monopile or jacket foundation. The ESPs would serve as the interconnection point between the WTGs and the export cables. The ESPs would be located along the northwest edge of the WDA and would include step-up transformers and other electrical equipment needed to connect the 66 kV inter-array cables to the 220 kV offshore export cables. Between 6 and 10 WTGs would be connected through an inter-array cable that would be buried below the seabed and then connected to the ESPs. If the proposed Project uses more than one ESP, a 200 kV inter-link cable would be required to connect the ESPs together. Each ESP would contain up to approximately 123,210 gallons (466,400 liters) of transformer oil, approximately 349 gallons (1,320 liters) of general oil, and approximately 5,719 gallons (21,560 liters) of diesel fuel. WTGs and ESPs would be equipped with secondary containment sized according to the largest oil chamber. As mentioned above, COP Section 4.2 provides additional details related to chemicals and their anticipated volumes (Volume I; Epsilon 2020a). Vineyard Wind has stated that the Proposed Action would be designed to meet International Electrotechnical Commission standards for WTGs. The WTGs would be designed to endure sustained wind speeds of up to 112 miles per hour (mph) (182.2 kilometers per hour [kph]) and gusts of 157 mph (252.7 kph). WTGs would also automatically shut down when wind speeds exceed 69 mph (111 kph). In addition, the structures would be designed for maximum wave heights greater than 60 feet (18.3 meters) (Vineyard Wind 2018b).

The WTGs and ESPs would include a nighttime obstruction lighting system that complies with Federal Aviation Administration (FAA) and U.S. Coast Guard (USCG) lighting standards and is consistent with BOEM best practices. Vineyard Wind's Lighting and Marking Plan would describe the lighting and marking system as part of the final layout plan, consistent with USCG standards. Such a plan would specify turbine paint colors and the configuration of lighting, and BOEM would require it to include justification for any deviations from BOEM's usual guidelines on lighting and marking. As outlined in Section 2.2.1, Vineyard Wind may be required, as a condition of COP approval outlined in the ROD, to use either an Aircraft Detection Lighting System (ADLS) that would automatically activate lights when aircraft approach, or a system that automatically adjusts lighting intensity based on visibility conditions, either of which would require FAA approval for turbines within 12 nautical miles of land. Vineyard Wind would paint WTGs no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey to help reduce potential visibility against the horizon. The exact number, characteristics, and color of navigation lighting would be determined once a final layout plan has been submitted by Vineyard Wind to USCG. Additionally, Vineyard Wind has proposed that 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 Lighthouse Authorities guidance. Upon the developer's application to USCG, which has not yet been filed, a Private Aids to Navigation (PATONs) permit for each tower constructed would be issued. To further enhance marine navigation safety, sound signals[10] and/or automatic identification system (AIS) transponders may be included on selected structures.

Vineyard Wind would install foundations and WTGs using jack-up vessels or vessels capable of dynamic positioning,[11] as well as necessary support vessels and barges. Vessels would be equipped with a crane and a pile-driving hammer. Vineyard Wind would begin pile driving by using a soft start to help enable some marine life to

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[9] Section A.8.2 in Appendix A provides information related to the potential impacts of chemical spills from wind turbines. Additional specific information related to environmental risks, fate, and effects of chemicals associated with wind turbines on the Atlantic OCS can be found in Bejarano et al. (2013).

[10] In consultation with USCG, sound signals could include audible sound devices, such as horns, on the WTGs and ESPs.

[11] Dynamic positioning allows a vessel to maintain its position by using a computer-controlled system that operates the propellers and thrusters.

leave the area before driving intensity increases. ESP foundation installations may require specialized crane vessels. It is possible that monopiles would be transported to the WDA by floating them in the water while pulled by tugs. COP Section 4.2.3 provides more details about installation (Volume I; Epsilon 2020a).Vineyard Wind would place scour protection around all foundations to stabilize the seabed near the foundations as well as the foundations themselves. The scour protection would be approximately 3 to 6 feet (1 to 2 meters) in height, would extend away from the foundation as far as 92.5 feet (28.2 meters), and would consist of rock and stone ranging from 4 to 12 inches (10 to 30 centimeters). To maximize precision when placing scour protection, Vineyard Wind would use the fall pipe method whenever feasible (COP Volume I, Section 4.2.3.2; Epsilon 2020a).

Two offshore export cables in one cable corridor would connect the proposed wind facility to the onshore electrical grid (Figure 2.1-2). Each offshore export cable would consist of three-core 220 kV AC cables that would deliver power from the ESPs to the onshore facilities. The cable routes currently being considered contain several routing options. The OECC from the WDA could pass through the deepest part of Muskeget Channel proper, or it could pass atop the shoals to the east of the deepest area (Figure 2.1-2). The offshore export cables would approach Cape Cod and make landfall at Covell's Beach in Barnstable with a target burial depth of up to 5 to 8 feet (1.5 to 2.5 meters).

As part of the PDE, Vineyard Wind has proposed several cable route installation methods for the inter-array cables, inter-link cables, and offshore export cables. Vineyard Wind would typically bury the cables using a jet plow, mechanical plow, or mechanical trenching, as suited for the bottom type in the immediate area; other burial methods may be used more rarely. Vineyard Wind's expected installation tool for the offshore export cable from the landfall site out to approximately 1.2 miles (2 kilometers) offshore of the two Muskeget Channel route options is a jetting tool known as a vertical injector. This tool would penetrate into the seabed as a vessel is mechanically pulled forward on anchors while installing the cable through the tool, such that the tool can pass through areas of coarse deposits. While dredging remains in the PDE as a potential technique (and would be the maximum-case scenario impact), the anticipated use of the vertical injector tool is expected to avoid the need for dredging, as the vertical injector tool can achieve deeper penetration below sand waves and into the stable seabed. By utilizing this tool, the presence of sand waves is not expected to present a meaningful construction challenge to cable burial (Vineyard Wind 2019d). The hard bottom in Muskeget Channel is a mix of gravel, cobble, and boulder-sized material in a sand matrix (Attachment E in Epsilon 2018d). Within federal waters (south of Muskeget Channel), a type of jet plow/jet trencher would be used. Both tools are appropriate for the specific site conditions along the cable route and are higher specification tools than were used for previous power-cable burial projects in Southern New England where target depth was not reached in some areas. For the remainder of the offshore export cable, and for the inter-array cables, a jet plow/jet trencher tool would be used. Based on ongoing review of the 2018 survey data for the WDA, Vineyard Wind expects that cable protection is less likely to be needed in the WDA for the inter-array (and inter-link cables, if used) due to consistent geology and limited coarse materials. The expected installation method for the inter-array cables is to lay the cable section on the seafloor and then subsequently bury the cables using a jet plow/jet trencher. This tool is very suitable for the site conditions of relatively homogeneous consolidated sands, providing a high degree of confidence that sufficient burial would be achieved. Additionally, if sufficient burial is not achieved on the first pass, it is expected that a second or third attempt with the installation tool would be made to achieve sufficient burial. Requiring more than one pass increases the likelihood that cable burial would be achieved. In the event that the described processes above are unsuccessful, Vineyard Wind may elect to dredge a trench in order to bury the cable. No drilling or blasting would be required. Project engineers and contractors would use micro-routing of the cable to avoid hard-bottom areas to the greatest extent practicable, although hard bottom and complex bottom extend the full width of possible routes within the OECC between Martha's Vineyard and Nantucket Island and cannot be entirely avoided (Section 3.2.2 and Vineyard Wind 2019d). Contractors and engineers for Vineyard Wind would perform additional surveys and evaluation of geological conditions in the surface and shallow subsurface layers and develop the precise route by minimizing the following, in order of priority: length of hard-bottom habitat crossed, number of boulders encountered, volume of dredging required, and other factors; details are in the COP Addendum Section 1.2.3 (Epsilon 2019a). This process would minimize impact to hard-bottom habitat and complex bottom and maximize the likelihood of sufficient cable burial. In any hard-bottom areas that could not be avoided, the cable would be buried using the vertical injector jetting tool. As with any tool that fluidizes the seabed, this would tend to result in a less coarse, more sandy top layer of seafloor after use (COP Addendum, Appendix A;

Epsilon 2019a and COP Volume III, Appendix III-I; Epsilon 2020b; Vineyard Wind 2019c). Any large boulders along the route would be relocated prior to cable installation. The preliminary schedule would involve installing the cables in three segments during the fall of 2020 and spring or summer of 2021. Approximately 4 weeks prior to installation of a segment of the cables, a pre-lay grapnel run would be performed in all instances to locate and clear obstructions such as abandoned fishing gear and other marine debris. Following the pre-lay grapnel run, dredging within the OECC would occur (where necessary) to allow for effective cable laying through the sand waves. The majority of dredging would occur on large sand waves, which are mobile features. See COP Volume II-A, Figure 2.1-17, for an indication of places prone to large sand waves (COP Volume II-A, page 2-30; Epsilon 2018a). Vineyard Wind anticipates that dredging would occur within a corridor that is 65.6 feet (20 meters) wide and 1.6 feet (0.5 meter) deep, and potentially as deep as 14.7 feet (4.5 meters). Vineyard Wind is proposing to lay most of the offshore export cables using simultaneous lay and bury via jet embedment. For the inter-array cables, the expected installation method would be to lay the cable section on the seafloor and then subsequently bury it using a jet plow ("post-lay burial"). In certain areas, alternative installation methods may be needed. Although the COP is flexible, Vineyard Wind expects to achieve cable burial using the vertical injector jetting tool and the jet plow/jet trencher tool described above. In any case, cable burial would likely use a tool that slides along the seafloor on skids or tracks (up to 3.3 to 6.6 feet [1 to 2 meters] wide), which would not dig into the seafloor but would still cause temporary disturbance. The installation methodologies are described in detail in COP Volume I, Section 4.2.3 (Epsilon 2020a).

For the installation of the two offshore export cables, total dredging could impact up to 69 acres (279,400 m^2) and could include up to 214,500 cubic yards (164,000 cubic meters) of dredged material. Vineyard Wind could use several techniques to accomplish the dredging: trailing suction hopper dredge (TSHD) or jetting (also known as mass flow excavation).[12] TSHD would discharge the sand removed from the vessel within the 2,657-foot-wide (810-meter) cable corridor.[13] Jetting would use a pressurized stream of water to push sand to the side. The jetting tool draws in seawater from the sides and then jets this water out from a vertical down pipe at a specified pressure and volume. The down pipe is positioned over the cable alignment, enabling the stream of water to fluidize the sands around the cable, which allows the cable to settle into the trench. This process causes the top layer of sand to be side-casted to either side of the trench; therefore, jetting would both remove the top of the sand wave and bury the cable. Typically, a number of passes are required to lower the cable to the minimum target burial depth. Vineyard Wind expects to perform dredging, where needed, using a TSHD; however, Vineyard Wind expects that the use of the vertical injector tool would avoid the need for dredging, as the vertical injector tool can achieve deeper penetration below sand waves and into the stable seabed. If dredging is needed, the TSHD would dredge along the OECC until the hopper is filled to an appropriate capacity, then the TSHD would sail several hundred meters away (while remaining within the OECC) and then bottom dump the dredged material. Dredging and dumping would only occur within sand wave areas. However, the vertical injector tool is able to achieve burial even in sand waves, thus minimizing the need for dredging (Vineyard Wind 2019b).

Vineyard Wind would need to use vessels, vehicles, and aircraft during construction. The construction and installation phase of the Project would make use of both construction and support vessels to complete tasks in the WDA and along the OECC. Construction vessels would transit between the WDA and the New Bedford Marine Commerce Terminal (MCT); however, vessels may operate from other port facilities, as needed. During construction and installation, Vineyard Wind anticipates an average of approximately 25 vessels operating during a typical workday in the WDA and along the OECC. Vineyard Wind has noted that many of those vessels would remain in the WDA or OECC for days or weeks at a time, potentially making infrequent trips to port for bunkering and provisioning, if needed. Therefore, Vineyard Wind expects that proposed-Project construction would generate an average of seven daily trips to or from New Bedford Harbor or a secondary port each day. Of all the vessels used for construction/installation, approximately 16 would come from Europe. These vessels would be expected to

[12] TSHD can be used in sand waves of most sizes, whereas the jetting technique is most likely to be used in areas where sand waves are less than 6.6 feet (2 meters) high. Therefore, the sand wave dredging could be accomplished entirely by the TSHD on its own, or the dredging could be accomplished by a combination of jetting and TSHD, where jetting would be used in smaller sand waves and the TSHD would be used to remove the larger sand waves.

[13] Vineyard Wind anticipates that the TSHD would dredge along the OECC until the hopper was filled to an appropriate capacity, then the TSHD would sail several hundred meters away (while remaining within the 2,657-foot [810-meter] corridor) and bottom dump the dredged material.

remain on site for the duration of the work that they are contracted to perform, which could range from 2 to 12 months.

During the proposed Project's most active construction period, Vineyard Wind estimates that a maximum of approximately 46 vessels could operate simultaneously within the WDA or OECC. In an extreme case, all 46 vessels could need to travel to or from New Bedford or a secondary port in the same day; however, Vineyard Wind estimates that activities during the proposed Project's most active period would typically generate 18 vessel trips per day to or from ports. The maximum number of vessels involved in the proposed Project at any one time is highly dependent on the Project's final schedule, the final design of the Project's components, and the logistics solution used to achieve compliance with the Jones Act (COP Volume III, Section 7.8 and Appendix III-I; Epsilon 2020b). Vessel types proposed for the cable installation could be vessels capable of dynamic positioning, anchored vessels, self-propelled vessels, and/or barges. All Project vessels are subject to applicable USCG regulations for ballast water management. The regulatory requirements for ballast water management and control of non-indigenous species can be found in 33 C.F.R. Part 151 Subpart C, 33 C.F.R. Part 151 Subpart D, and 46 C.F.R. Subpart 162.060. These requirements apply to all U.S. and foreign-flagged commercial vessels that are equipped with ballast water tanks and operate in waters of the U.S. Additional information can be found in the Navigation and Vessel Inspection Circular 01-18, Ballast Water Management for Control of Non-Indigenous Species in Waters of the United States (USCG 2018). The proposed Project may require anchoring of vessels, especially during the cable burial process. Anchoring would avoid sensitive seafloor habitats to the greatest extent practicable and would be completely prohibited in eelgrass beds. In addition, Vineyard Wind has committed to collect additional data within Muskeget Channel and further classify this benthic habitat in order to further avoid sensitive seafloor habitats. BOEM will continue to work with NMFS to share the additional data and classifications and will reinitiate the Essential Fish Habitat (EFH) consultation if BOEM substantially revises the Proposed Action in a manner that may adversely affect EFH or if new information becomes available that affects the basis for the conservation recommendations. Where it is considered impracticable to avoid a sensitive seafloor habitat, use of mid-line anchor buoys would be utilized, where feasible and considered safe, as a potential measure to reduce and minimize potential impacts from anchor line sweep.

Protection conduits installed at the approach leading to each WTG and ESP foundation would protect all offshore export cables and inter-array cables.

In the event that cables cannot achieve proper burial depths or where the proposed offshore export cables crosses existing infrastructure, Vineyard Wind could use the following protection methods: (1) rock placement, (2) concrete mattresses, or (3) half-shell pipes or similar product made from composite materials (e.g., Subsea Uraduct from Trelleborg Offshore) or cast iron with suitable corrosion protection.[14] Rock placement involves laying rocks on top of the cable to provide protection. Concrete mattresses are prefabricated flexible concrete coverings that are laid on top of the cable. In certain cases, the mattresses may be filled with grout or sand (referred to as grout/sand bags); this method is generally applied on smaller-scale applications than standard concrete mattresses. Lastly, half-shell pipes or similar products could be used that are made from composite materials or cast iron with suitable corrosion protection. Vineyard Wind has conservatively estimated that up to 10 percent (approximately 27.5 miles [44.3 kilometers]) of the export, inter-array, and inter-link cables would require one of these protective measures (COP Volume III, Table 6.5-5; Epsilon 2020b). Based on ongoing review of the 2018 survey data for the WDA, Vineyard Wind expects that cable protection is less likely to be needed in the WDA for the inter-array and inter-link cables due to consistent geology to the cable burial depth with limited coarse material. For the offshore export cables, the geology is more variable closer to shore. According the Vineyard Wind's initial assessment of burial performance as specified in their cable burial risk assessment report, the kilometer posts (KPs) between the ESP (KP 62.6) and KP 42.6 would mostly not need cable protection, except between KP 51.8 and KP 48.7 where up to 1,214 feet (370 linear meters) of cable protection may be necessary (Appendix A; Epsilon 2019a). After KP 48.7 (just south of Muskeget Channel continuing towards shore), the sediment becomes much more variable and so does the risk for needing cable protection. Extensive and iterative analyses of the data would take place up until the time

[14] Half-shell pipes come in two halves and are fixed around the cable to provide mechanical protection. Half-shell pipes or similar solutions are generally used for short spans, at crossings or near offshore structures, where there is a high risk from falling objects. The pipes do not provide protection from damage due to fishing trawls or anchor drags (COP Volume I, Section 3.1.5.3; Epsilon 2020a).

of installation in an effort to ensure burial and avoid the use of cable protection. These analyses may allow Vineyard Wind to identify areas with a greater risk of insufficient cable burial; however, final locations for cable protection, if needed, would not be known until completion of proposed Project installation activities. The potential impacts associated with implementation of the cable protection methods specified above are described in the Chapter 3 resource sections.

2.1.1.1.3. Construction Facilities

Port facilities used for construction would include the 26-acre (0.1 km^2) MCT and possibly other nearby ports (Figure 2.1-3). Vineyard Wind would use the MCT to offload shipments of components, prepare them for installation, and load components onto jack-up barges or other suitable vessels for delivery to the WDA (COP Volume I, Section 4.2; Epsilon 2020a).

Vineyard Wind and their turbine supplier have a lease agreement with MCT, and Vineyard Wind expects that MCT would support most, if not all, of the necessary operations for the turbine components. In addition, Vineyard Wind may stage certain activities from other Massachusetts or North Atlantic commercial ports (Figure 2.1-3).

Vineyard Wind has indicated that ports may require site-specific modifications, shoreline stabilization, maintenance dredging, installation of various equipment to berth construction and installation vessels, as well as new structures to accommodate workforce and equipment needs; however, Vineyard Wind does not propose to direct or implement any potential port improvements. Rather, Vineyard Wind would consider whether the ports are suitable for Vineyard Wind's needs if and when the owner or lessor makes any necessary upgrades. Therefore, none of these port upgrades would occur as a direct result of the Proposed Action (COP Volume I, Section 3.2.5; Epsilon 2020a). Table 2.1-3 lists the ports that Vineyard Wind could use for the proposed Project.

Table 2.1-3: Potential Construction Ports

Stage [a]	Port
Construction Staging/Fabrication	Brayton Point, Somerset, Massachusetts
	Montaup, Somerset, Massachusetts
	Other New Bedford Ports, Massachusetts
	Providence, Rhode Island
	Quonset Point, North Kingstown, Rhode Island
	Canadian Ports [b]

[a] Vineyard Wind has not identified any ports that could be used during proposed Project operations and maintenance other than the New Bedford Marine Commerce Terminal or Vineyard Haven Harbor.
[b] Vineyard Wind states that it is considering the ports of Saint John, New Brunswick, and Halifax and Sheet Harbour, Nova Scotia.

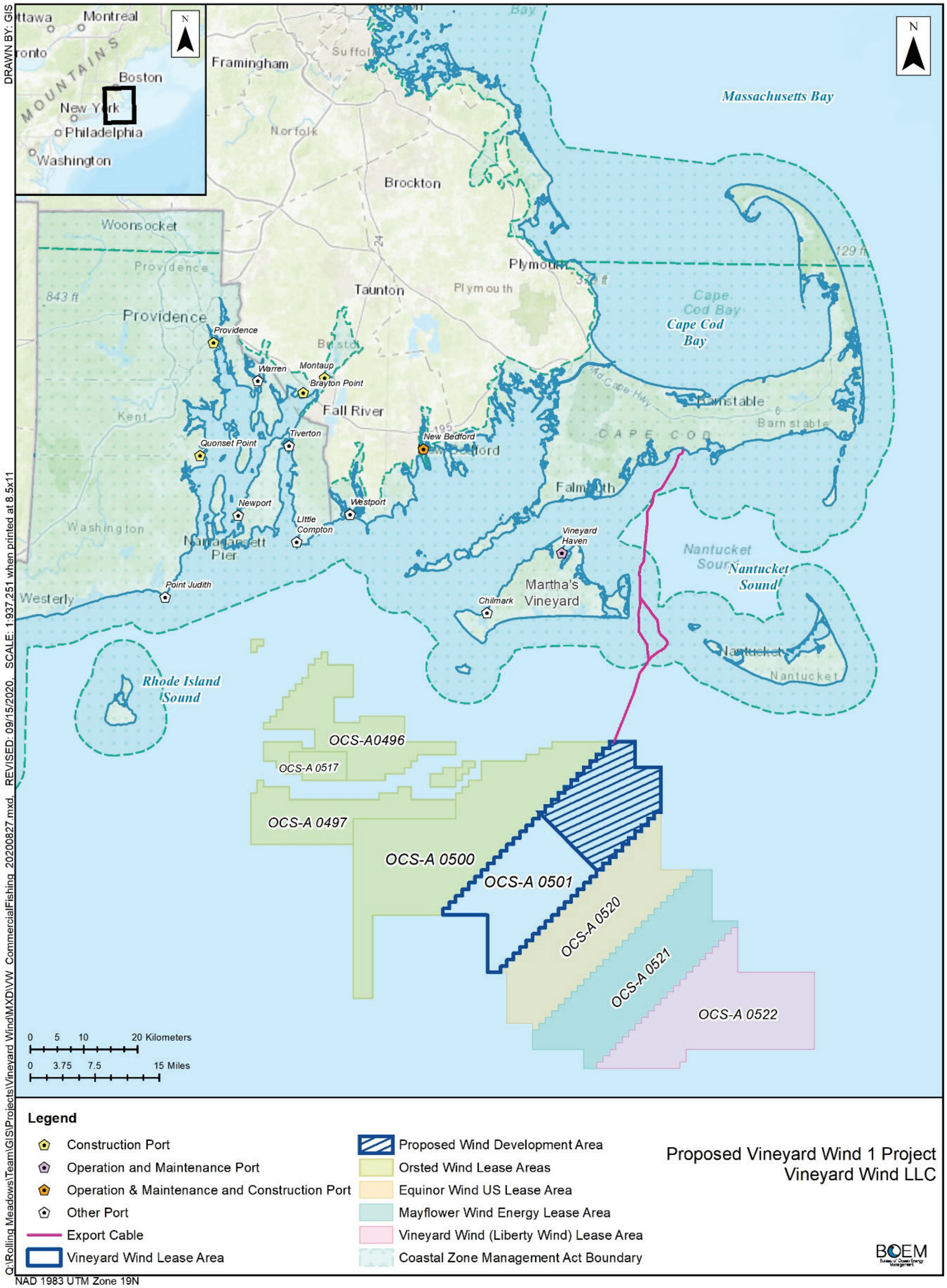


Figure 2.1-3: Proposed Port Facilities for Construction, Operation, and Maintenance

2.1.1.2. Operations and Maintenance

The proposed Project would have an operating period of 30 years.[15] Vineyard Wind would monitor operations continuously from the Operations and Maintenance Facilities and possibly other remote locations as well. Specifically, Vineyard Wind would use a new operations and maintenance facility in Vineyard Haven on Martha's Vineyard. The Operations and Maintenance Facilities would include offices, control rooms, warehouses, shop space, and pier space, which may be supplemented by continued use of the MCT on the mainland; however, as mentioned above, Vineyard Wind does not propose to direct or implement any port improvements. The Operations and Maintenance Facilities would be located at an existing marina, and the marina owner has existing plans to upgrade the facilities to accommodate additional marine industrial uses and to increase the existing facility's protection from storms, irrespective of whether or not Vineyard Wind utilizes this location for their proposed Project. The proposed upgrades by the marina owner include, but are not necessarily limited to, the removal and replacement of an existing solid-filled pier with a pile-supported pier; installation of catwalks, barge ramps, and a bulkhead; beach nourishment; and dredging and filling activities. Therefore, improvements to the Vineyard Haven Port would not occur as a direct result of the Proposed Action (COP Volume I, Section 3.2.5; Epsilon 2020a). The use of Vineyard Haven Port, however, is considered part of the Proposed Action.

The proposed Project would include a comprehensive maintenance program, including preventive maintenance (e.g., oil changes) based on statutory requirements, original equipment manufacturers' guidelines, and industry best practices. In addition, Vineyard Wind would maintain an Oil Spill Response Plan, an Emergency Response Plan, and a Safety Management System, including an environmental management system, (COP Volume I, Appendices I-A and I-B; Epsilon 2020a) that would be issued to the vessels and construction firms. These plans would be in place since before construction and installation activities begin, and would be reviewed and approved by BOEM and Bureau of Safety and Environmental Enforcement. Vineyard Wind would inspect WTGs, foundations, ESPs, inter-array cables, offshore export cables, landfall locations, onshore export cables, and other parts of the proposed Project using methods appropriate for the location and element characteristics.

2.1.1.2.1. Onshore Activities and Facilities

The onshore substation site, onshore export cables, and splice vaults would require minimal maintenance. When needed, Vineyard Wind would conduct inspections and repairs according to industry standards for land-based power transmission facilities.

2.1.1.2.2. Offshore Activities and Facilities

Vineyard Wind would design WTGs and ESPs to operate by remote control, so personnel would not be required to be present except to inspect equipment and conduct repairs. Spare parts would be housed at the Operations and Maintenance Facilities, and possibly other facilities for larger parts, and would be available so that Vineyard Wind could initiate repairs expeditiously.

Vineyard Wind would need to use vessels, vehicles, and aircraft during operations and maintenance. The Proposed Action would generate trips by crew transport vessels (about 75 feet [22.3 meters] in length), multipurpose vessels, and service operations vessels (260 to 300 feet [79.2 to 91.4 meters] in length), with larger vessels likely based at the MCT and smaller vessels likely based at Vineyard Haven. In a typical year, the Proposed Action would generate approximately 401 to 887 vessel trips per year depending on the operation and maintenance scenario implemented, which would include crew transfer vessel trips, multipurpose vessel trips, and service operation vessel trips (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2020a). Dedicated crew transport vessels specifically designed for offshore wind energy work would provide access. These vessels would be based primarily at the Operations and Maintenance Facilities. Vineyard Wind may also use helicopters for access or visual inspections. The helicopters would be based at a general aviation airport near the Operations and Maintenance Facilities.

[15] Vineyard Wind's lease with BOEM (Lease OCS-A 0501) has an operations period of 25 years that commences on the date of COP approval (see https://www.boem.gov/Lease-OCS-A-0501/ at Addendum B; see also 30 C.F.R. § 585.235(a)(3)). Vineyard Wind would need to request an extension of its operations period from BOEM in order to operate the proposed Project for 30 years. For purposes of the maximum-case scenario and to ensure NEPA coverage if BOEM grants such an extension, however, the FEIS analyzes a 30-year operations period.

Vineyard Wind would change WTG gearbox oil after approximately 5, 13, and 21 years of service. See COP Section 4.3 for additional operations and maintenance information (Volume I; Epsilon 2020a).

2.1.1.3. Decommissioning

According to 30 C.F.R. Part 585 and other BOEM requirements, Vineyard Wind would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. All foundations would need to be removed to a depth of 15 feet (4.6 meters) below the mudline (30 C.F.R. § 585.910(a)). Absent permission from BOEM, Vineyard Wind would have to complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed. Vineyard Wind has submitted a conceptual decommissioning plan as part of the COP, and the final plan would outline the Vineyard Wind's process for managing waste and recycling proposed Project components (Volume I, Section 4.4; Epsilon 2020a). Although the proposed Project has a designed life span of 30 years, some installations and components may remain fit for continued service after this time. Vineyard Wind would have to apply for an extension if it wanted to operate the proposed Project for more than the operations term.

BOEM would require Vineyard 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 C.F.R. § 585.905). Upon completion of the technical and environmental reviews, BOEM may approve, approve with conditions, or disapprove the lessee's decommissioning application. This process would include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Vineyard Wind would need to obtain separate and subsequent approval from BOEM to retire any portion of the Proposed Action in place. 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, Vineyard Wind would have to submit a bond that would be held by the U.S. government to cover the cost of decommissioning the entire facility if Vineyard Wind would not otherwise be able to decommission the facility. Furthermore, pursuant to 30 C.F.R. Part 585 and other BOEM requirements, Vineyard Wind would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. Vineyard Wind would need to obtain separate and subsequent approval from BOEM to retire any portion of the Proposed Action in place.

2.1.1.3.1. Onshore Activities and Facilities

Depending on the needs of the host town, Vineyard Wind may leave onshore facilities in place for future use. Cable removal, if required, would probably proceed using truck-mounted winches and handling equipment. There are no plans to disrupt streets or onshore public utility ROWs by excavating or deconstructing buried facilities.

2.1.1.3.2. Offshore Activities and Facilities

Vineyard Wind would drain WTG and ESP fluids into vessels for disposal in onshore facilities before disassembling the structures and bringing them to port. Foundations would be temporarily emptied of sediment, cut 15 feet (4.6 meters) below the mudline in accordance with BOEM regulations (30 C.F.R. § 585.910(a)) and removed. The portion of foundations buried below 15 feet (4.6 meters) would remain, and the depression refilled with the temporarily removed sediment. In consideration of mobile gear fisheries (i.e., dredge and bottom trawl gears), Vineyard Wind is committed to removing scour protection during decommissioning. As explained in the COP (Section 4.4.4), offshore cables could be retired in place or removed, subject to 30 C.F.R. § 585.900.

2.1.2. Alternative C—No Surface Occupancy in the Northernmost Portion of the Project Area Alternative

Under Alternative C[16], no surface occupancy would occur in the northernmost portion of the WDA, resulting in the exclusion of some of the northernmost WTG locations, which would be relocated to the southern WDA as shown on Figure 2.1-4. The impact assessment of this alternative includes the following assumptions:

- The acreage of the WDA would remain unchanged, and all WTGs and ESPs would be sited within the same sized footprint as described under the Proposed Action.
- The six northernmost WTG locations identified in Figure 2.1-4 would be excluded from the northernmost portion of the WDA and instead placed along the southern portion of the WDA. A new inter-array cable would link these WTGs to the southern ESP(s).
- There would be no changes to ESP locations or the OECC route.
- Additional survey work may be required to address changes in six WTG placements and inter-array cable locations; however, these surveys would be limited in nature and Project delays would not be anticipated.

2.1.3. Alternative D—Wind Turbine Layout Modification Alternative

Alternative D was developed through the scoping process for the DEIS and included information described in Jedele (2018) and information provided by the Commercial Fisheries Center of Rhode Island (CFCRI 2018). These comments regarding a minimum of a 1-nautical-mile spacing and an east-west layout were supported by members of the Commercial Fisheries Center of Rhode Island, including Rhode Island Commercial Fishermen's Association, Rhode Island Lobstermen’s Association, Eastern New England Scallop Association, Ocean State Fishermen’s Association, Rhode Island Party and Charter Boat Association, Town Dock Commercial Fishing Fleet, and Newport Fishermen’s Association. Alternative D includes two sub-alternatives related to the layout of the WTGs. Prior to COP approval, BOEM would require substantial additional survey work for the two sub-alternatives to resolve data gaps for WTG placements and inter-array cable locations not contemplated in Alternative A (the Proposed Action).

2.1.3.1. Alternative D1—One-Nautical-Mile Wind Turbine Spacing Alternative

This alternative would ensure all WTGs having a minimum spacing of 1 nautical mile between them (the Proposed Action allows for an average spacing between WTGs of approximately 0.86 nautical mile). Furthermore, the corridors between turbines would also be a minimum of 1 nautical mile wide to potentially reduce conflicts with existing ocean uses such as commercial fishing and marine navigation. The impact assessment of this sub-alternative includes the following assumption:

- There would be no changes to the number of WTGs, ESP locations, or the OECC route.
- There would be no demarcated transit corridors within the WDA. The total acreage of the WDA would increase by approximately 22 percent from 75,614 acres (306 km^2) to approximately 92,217 acres (373 km^2) as a result of requiring additional space to accommodate WTGs spaced at a greater distance than the Proposed Action (Figure 2.1-5). To calculate this change in area, BOEM assumes the distance between the southernmost row of WTGs and the southern WDA boundary to be the same as under the Proposed Action.[17]
- The amount and length of inter-array cabling would increase and exceed the maximum design parameter in the COP PDE of 171 miles (275 kilometers) due the spacing between WTGs. The total length of inter-array cabling is estimated to be approximately 186 miles (200 kilometers) (Michael Clayton, Pers. Comm., March 24, 2020). This would result in up to a 9 percent increase of additional inter-array cabling.
- The construction schedule and timing may not be the same as under the Proposed Action. The additional survey work could result in project delays of one to two years in order to conduct the surveys (as required by BOEM’s regulations), process the data, and redesign the turbine foundations (each foundation is unique to the particular site conditions of where it would be placed).

[16] See footnote 2, page 2-1. Alternative B is not analyzed because Covell’s Beach is the only landfall currently proposed.

[17] If the regional navigational safety corridor discussed above is established for fishing vessels, WTG placements associated with this alternative would need to be placed south of the navigational safety corridor, thus increasing the footprint required for this alternative.

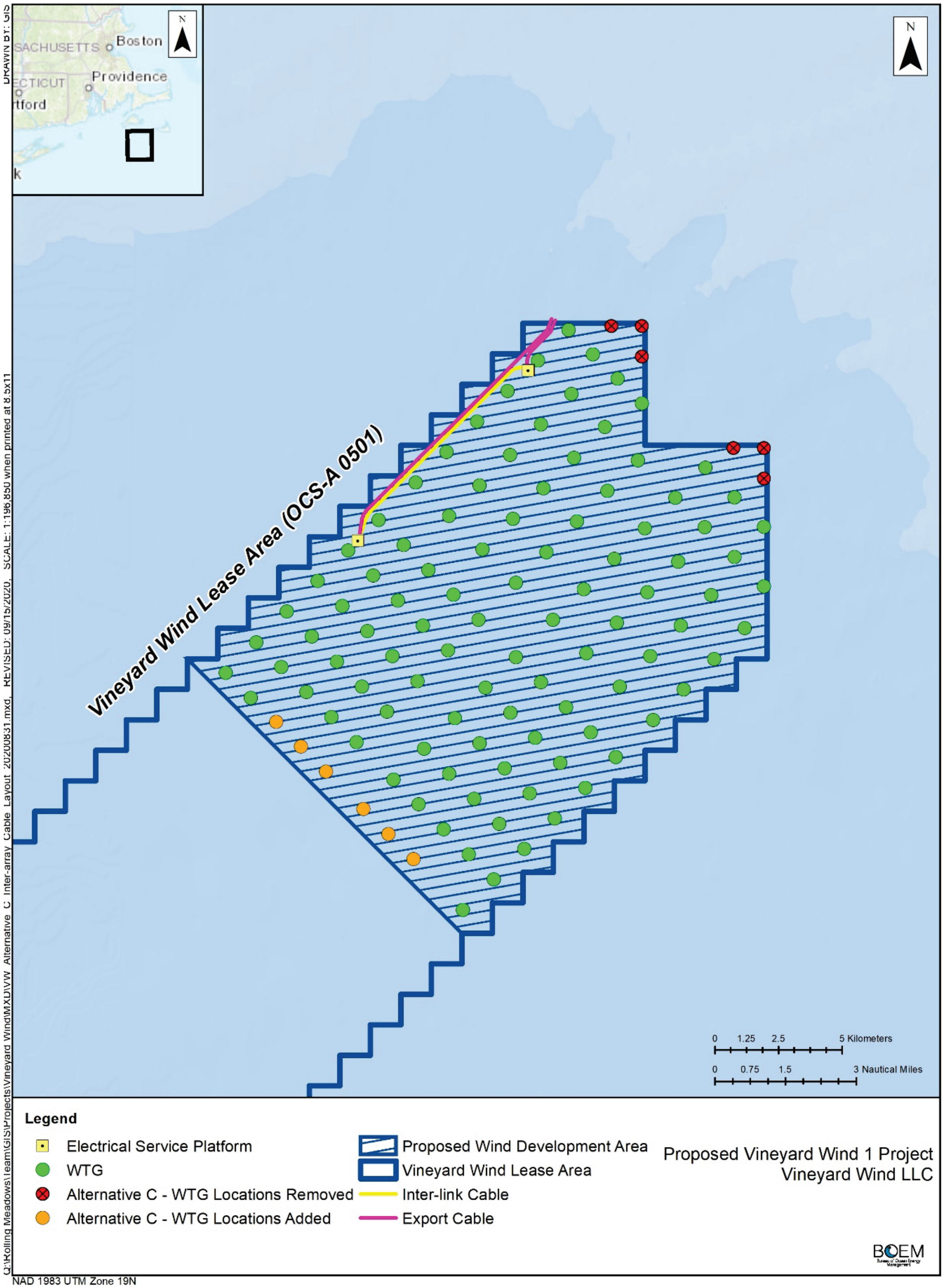
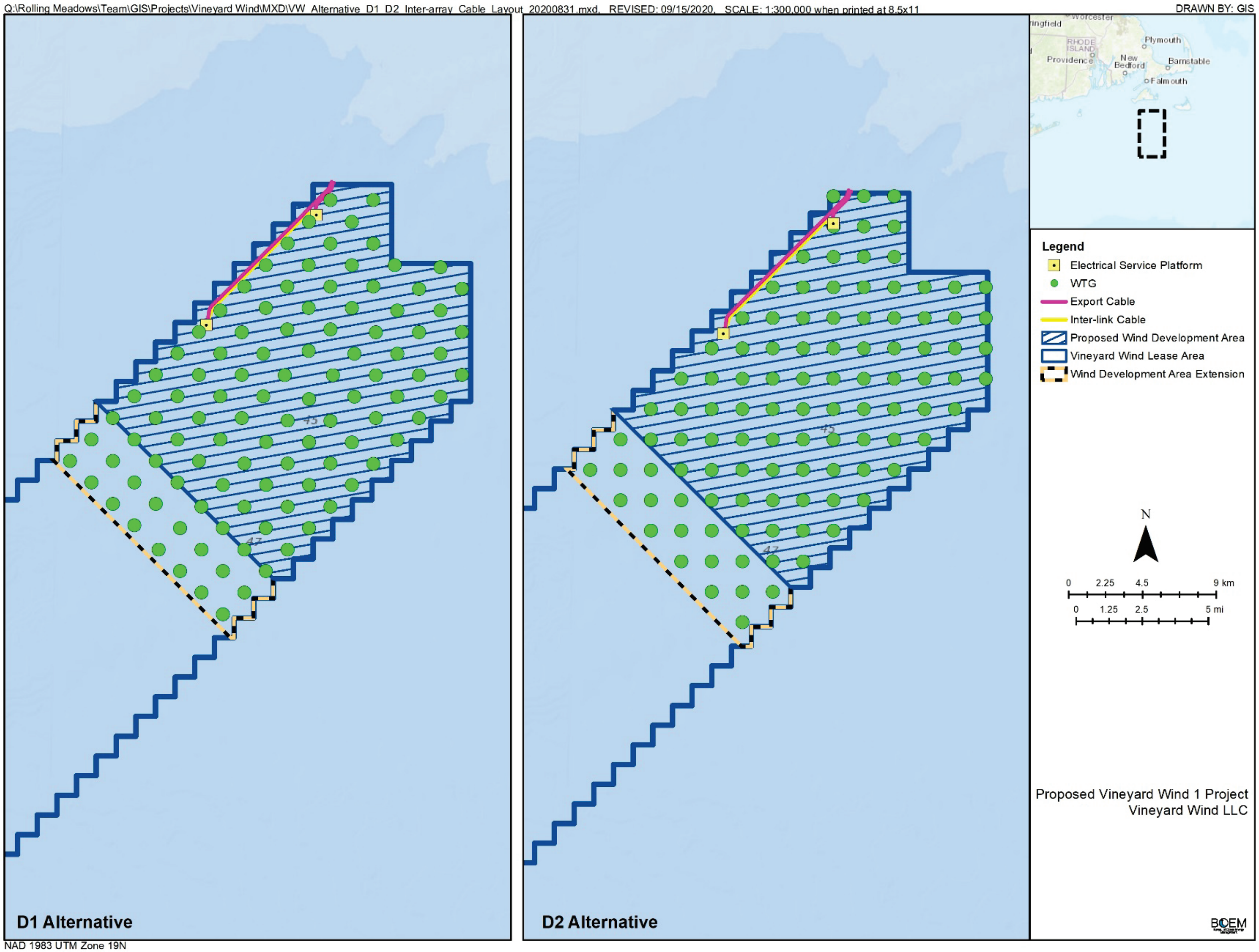


Figure 2.1-4: Alternative C—No Surface Occupancy in the Northernmost Portion of the Project Area Alternative



Note: The layout shown is for illustrative purposes only.

Figure 2.1-5: Alternative D1—1-Nautical-Mile WTG Spacing and Alternative D2—East-West and 1-Nautical-Mile WTG Layout

2.1.3.2. Alternative D2—East-West Wind Turbine Layout Alternative

This alternative would arrange the WTG layout in an east-west orientation. In addition to the east-west orientation, this alternative would ensure all WTGs would have a minimum spacing of 1 nautical mile between them (the Proposed Action allows for an average spacing between the WTGs of approximately 0.86 nautical mile). This alternative would be consistent with the Final Massachusetts and Rhode Island Port Access Route Study (MARIPARS) and the Rhode Island and Massachusetts (RI and MA) Lease Area developers' agreement. The impact assessment of this sub-alternative includes the following assumptions:

- There would be no changes to the number of WTGs or the OECC route.
- There would be no demarcated transit corridors within the WDA.
- The acreage of the WDA throughout which Project components would be distributed would increase[17] (Figure 2.1-5).
- The amount and length of inter-array cabling would increase and exceed the maximum design parameter in the COP PDE of 171 miles (275 kilometers) due the spacing between WTGs. The total length of inter-array cabling is estimated to be approximately 186 miles (200 kilometers) (Michael Clayton, Pers. Comm., March 24, 2020). This would result in up to a 9 percent increase of additional inter-array cabling.
- The construction schedule and timing may not be the same as under the Proposed Action. The additional survey work could result in project delays of one to two years in order to conduct the surveys (as required by BOEM's regulations), process the data, and redesign the turbine foundations (each foundation is unique to the particular site conditions of where it would be placed).

In September 2018, the Massachusetts Fisheries Working Group on Offshore Wind and USCG identified a 2-nautical-mile-wide, northwest-southeast oriented navigational safety corridor south of the WDA but within the Wind Energy Area (WEA). Subsequent to that meeting, additional workshops were held to discuss transit options in and around the New England lease areas (RODA 2018). Additionally, the USCG began preparing the MARIPARS to evaluate the need for establishing vessel routing measures to enhance navigational safety (84 Fed. Reg.11314 [March 26, 2019]). USCG's Final MARIPARS, published in May 2020, evaluated vessel traffic through the lease areas and recommended all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would pass one WTG on either side every 1 nautical mile when traveling north-south or east-west, and every 0.6 to 0.8 nautical mile when traveling northwest-southeast or northeast-southwest (USCG 2020b). The Final MARIPARS did not recommend implementation of a wider transit lane. In response to concerns of increased navigational safety risks due to all transiting traffic being funneled into a navigational safety corridor, the USCG stated that "the standard and uniform [1-nautical-mile] grid pattern… should alleviate… concerns [with compression and funneling traffic through relatively narrow lanes] by providing vessels with sufficient spacing and multiple options to transit safely through the array. If the entire MA/RI [Massachusetts/Rhode Island] WEA is developed consistent with such a grid pattern, mariners could choose among the many resulting navigation safety corridors to safely navigate through the entire MA/RI WEA" (USCG 2020b).

2.1.4. Alternative E—Reduced Project Size Alternative

Alternative E would limit the proposed Project to up to 84 WTGs. Under this alternative, depending on the turbine capacity used, this alternative could involve as few as 57 WTGs or as many as 84 WTGs. As discussed in the DEIS, this alternative would still allow Vineyard Wind to select from any of the 106 proposed WTG positions. On November 9, 2018, Vineyard Wind informed Rhode Island's Coastal Resources Management Council that they could use the largest WTG commercially available and would only need 84 WTG locations to achieve an approximately 800 MW capacity project (Vineyard Wind 2018c). In addition, on November 27, 2018, Vineyard Wind announced their preferred WTG supplier and indicated that 84 units of 9.5 MW WTGs would be expected to be utilized (Vineyard Wind 2018d). The impact assessment of this alternative includes the following assumptions:[18]

[18] Although Vineyard Wind has indicated that the largest capacity WTG currently available is 9.5 MW, the PDE as well as the impact assessment of the Proposed Action includes use of up to 14 MW WTGs to allow for potential advancements in technology or commercial availability.

- The ESP locations and the OECC route would be the same as the Proposed Action.
- The spacing between each of the transit corridors would be at least the same distance as the Proposed Action, but could be greater. The locations of the transit corridors themselves would remain the same.
- The construction schedule and timing would be the same as the Proposed Action.
- The acreage of the WDA would likely decrease.
- The use of 9.5 to 14 MW WTGs would be required for approximately 800 MW total power generation.
- The 57 to 84 WTGs would be located within the 106 locations presented as part of the Proposed Action by Vineyard Wind.

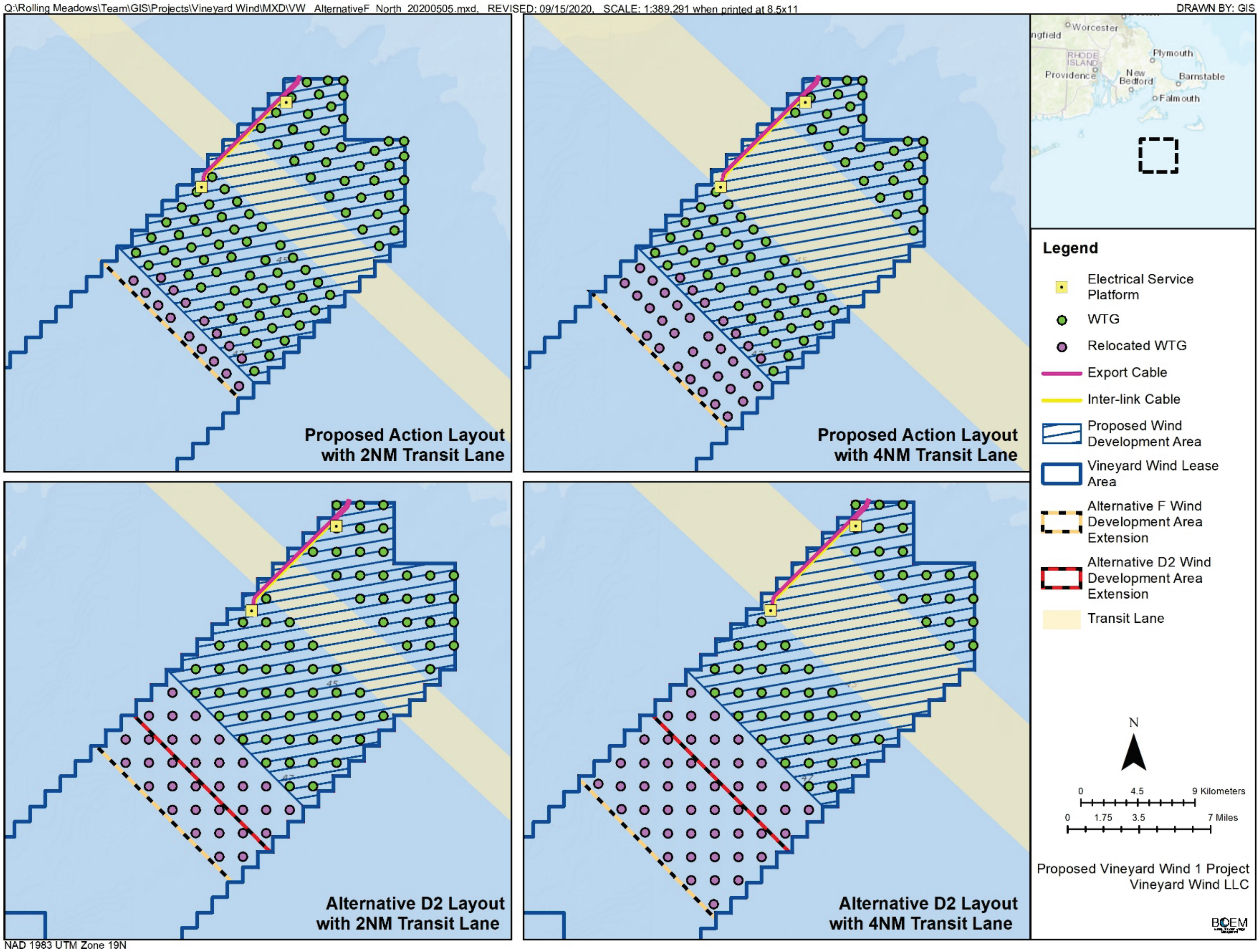
2.1.5. Alternative F—Vessel Transit Lane Alternative

A new alternative was added and analyzed in the SEIS and is included in this FEIS.[19] Alternative F, Vessel Transit Lane Alternative, includes a new vessel transit lane in response to the January 3, 2020, Responsible Offshore Development Alliance (RODA) layout proposal (Figure 2.1-6) (RODA 2020). The RODA proposal includes designated transit lanes, each at least 4 nautical miles wide (Figure 2.1-7). Although the proposal includes six total transit lanes, only one intersects the Vineyard Wind 1 Project WDA, as shown in Figure 2.1-6, the action for which this FEIS is being prepared.

The purpose of the proposed northwest/southeast transit corridor would be mainly to facilitate vessel transit from southern New England ports—primarily New Bedford—to fishing areas on Georges Bank.

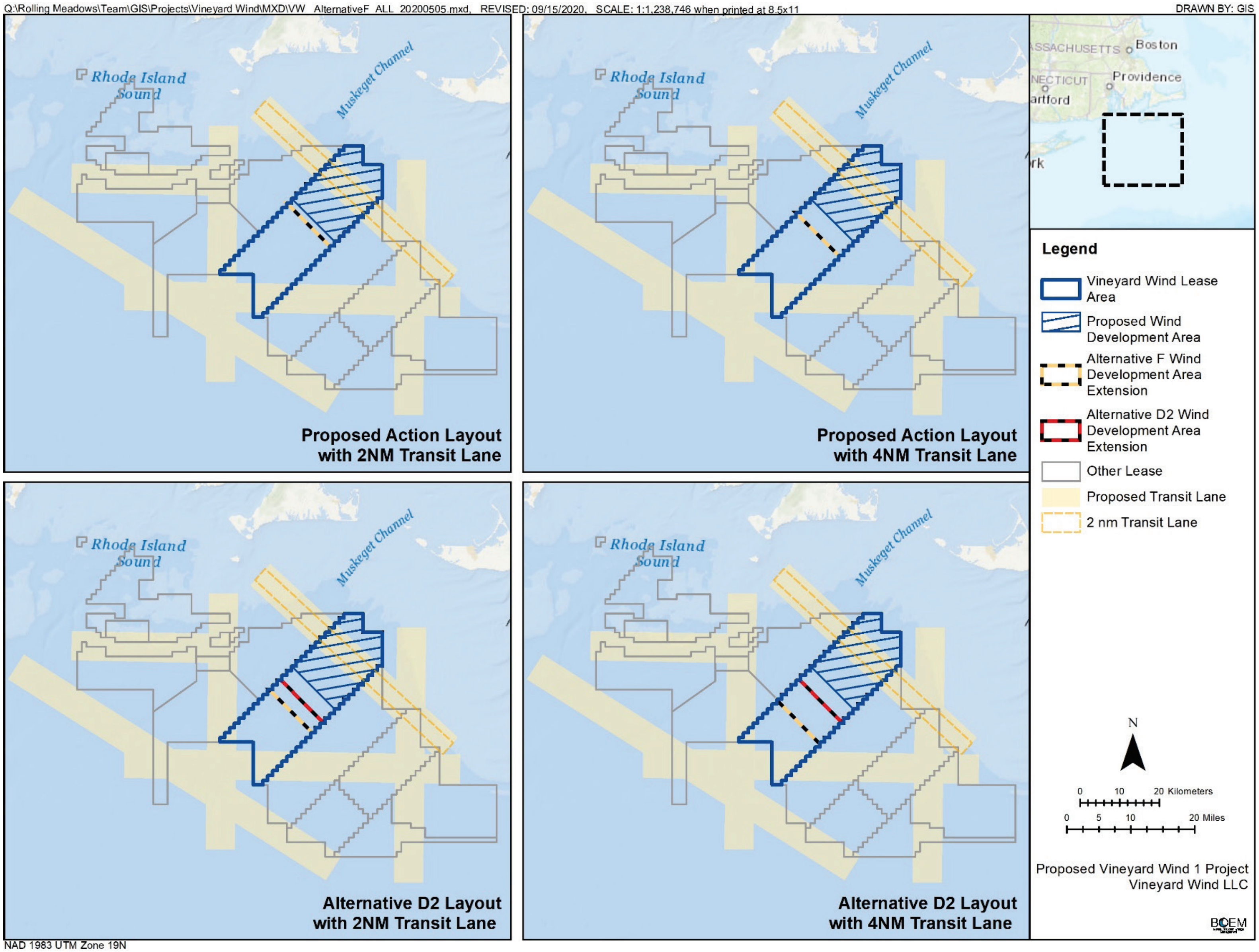
The WTGs that would have been located within the transit lane proposed to intersect the WDA would not be eliminated from the Proposed Action; but instead, the displaced WTGs would be shifted south within the Vineyard Wind lease area. Therefore, the number of placement locations would remain the same as assumed under the Proposed Action. Under Alternative F, a 2- and a 4-nautical-mile transit lane are analyzed by BOEM to provide the Secretary of the Interior with an assessment that is representative of transit lanes from 1 to 4 nautical miles wide. In this analysis, BOEM considers the effect of the single transit lane through the WDA on all alternatives considered, but focuses on the impacts from the combination of the new Alternative F with Alternative A and Alternative D2 layout alone because these analyses are expected to be similar to combinations with the other alternatives. The placement location of the transit lane assessed in this analysis (Figure 2.1-6) is based on the submission from RODA. In addition, this location would be the most impactful scenario. BOEM's decision maker could select this alternative and locate the lane elsewhere in the lease area. In addition, the FEIS considers the other five transit lanes that would intersect the other planned action lease areas to the extent that the impacts of those additional lanes would contribute to overall impacts in the analysis area considered for each resource area assessed.

[19] This new alternative describes "transit lanes" as requested by the RODA. BOEM has no legal authority to require vessels to transit particular lanes through the proposed Project, although BOEM can manage the placement of structures attached to the seabed. That noted, this document will use the term "transit lane" throughout in discussion concerning Alternative F.



Note: The layouts shown are for illustrative purposes only.

Figure 2.1-6: Alternative F—Vessel Transit Lane Alternative



Note: The layouts shown are for illustrative purposes only.

Figure 2.1-7: Alternative F—Vessel Transit Lane Alternative with Six Transit Lanes

The impacts associated with establishing a transit lane through the lease area are considered separately for each resource in Chapter 3 and Appendix A, with special focus on the most potentially affected resources such as navigation and commercial fishing. To focus on the impacts of most concern, BOEM has included the analysis of resources with no greater than an overall **minor** adverse effects in Appendix A. In addition, in the context of reasonably foreseeable environmental trends, the ongoing and planned actions including the Proposed Action impacts of additional transit lanes are analyzed where the additional lanes intersect with a resource's geographic analysis area. BOEM's impact assessment for this new alternative includes the following assumptions (Figure 2.1-6):

- There would be no changes to the total number of WTGs or ESPs.
- One of the two ESPs presented in the PDE could be located further south than anticipated under the Proposed Action.
- The OECC route would be longer due to shifting project elements further into the southern portion of the lease area.
- The acreage of the WDA throughout which Project components would be distributed could increase by up to 61 percent depending on the option selected.
- The amount and length of inter-array cabling would increase and exceed the maximum design parameter in the Vineyard Wind COP PDE of 171 miles (275 kilometers) due to shifting WTGs further south in the lease area. The total length of inter-array cabling is estimated to be between 221 and 234 miles (355 and 376 kilometers) (Michael Clayton, Pers. Comm., March 24, 2020) depending on the width of the transit lane, number of WTGs utilized, and WTG arrangement within the WDA. This would result in up to a 37 percent increase of additional inter-array cabling.
- The Proposed Action Layout with the implementation of a 2-nautical-mile transit lane would result in the following:
  - Out of a total of 2 ESPs and 106 WTG placement locations, up to 16 WTG placements would be relocated outside the proposed transit lane. Of these, seven WTG placements would be relocated to the southern portion of the WDA, and nine would be outside the WDA.
  - Acreage increase of the WDA throughout which Project components would be distributed: 12 percent.
- Proposed Action Layout with the implementation of a 4-nautical-mile transit lane would result in the following:
  - Out of a total of 2 ESPs and 106 WTG placement locations, up to 1 ESP and 34 WTG placements would be relocated outside the proposed transit lane. Of these, 7 WTG placements would be relocated to the southern portion of the WDA and 27 would be outside the WDA.
  - Acreage increase of the WDA throughout which Project components would be distributed: 25 percent.
- Alternative D2 Layout (1 x 1 nautical mile spacing) with the implementation of a 2-nautical-mile transit lane would result in the following:
  - Out of a total of 2 ESPs and 106 WTG placement locations, up to 16 WTG placements would be relocated outside the proposed transit lane, and a total of 33 placements would be relocated outside the WDA.
  - Acreage increase of the WDA throughout which Project components would be distributed: 41 percent.
- Alternative D2 Layout (1 x 1 nautical mile spacing) with the implementation of a 4-nautical-mile transit lane would result in the following (this is equivalent to the RODA layout proposal):
  - Out of a total of 2 ESPs and 106 WTG placement locations, up to 1 ESP and 33 WTG placements would be relocated outside the proposed transit lane, and a total of 50 placements would be outside the WDA.
  - Acreage increase of the WDA throughout which Project components would be distributed: 61 percent.

Just as implementation of Alternatives D1 or D2 would pose some unique challenges (as described above), so too could implementation of Alternative F. In addition to the assumptions specified above as they relate to the impact assessment presented in Chapter 3, BOEM has considered the following technical and practical challenges associated with Alternative F.

- Implementation of Alternative F would delay proposed Project construction if significant additional survey work is required. Additional site characterization surveys for Alternative F, if required, would be similar to those described in Section 3.1.3 of BOEM's Environmental Assessment, with the attendant environmental impacts described in Section 4.2 (BOEM 2012a).

- Vineyard Wind's proposed 66 kV inter-array cables would experience additional transmission loss if cables are lengthened to accommodate the transit lanes assumed under Alternative F. Such transmission losses are not considered as part of the Project design and could translate to technical difficulties and additional unanticipated costs.
- Cable lengthening would require factory joints, which are not currently technically possible by cable manufacturers. Joints could increase the risk of potential cable failure, and repairing such failures could lead to increased environmental effects due to a variety of factors including bottom disturbance and vessel traffic.
- The space required for implementation of the transit lane could reduce the area available for Vineyard Wind to construct future projects within the lease area.

In addition, BOEM has considered the following technical and practical challenges of Alternative F as they relate to the assessment of reasonably foreseeable environmental trends and planned action impacts:

- If all six transit lanes proposed by RODA were implemented, the technical capacity of offshore wind power generation assumed in Chapter 1 would not be met. The magnitude of the diminished technical capacity would depend on the width of transit lanes implemented, but ultimately, less clean energy in the region would be produced. BOEM assumes this to be true of any combination of alternatives that includes Alternative F. As explained in Section 3.12.5, BOEM assumes that the addition of all six of the 4-nautical-mile transit lanes proposed by RODA would reduce the technical capacity of the RI and MA Lease Areas[20] by approximately 3,300 MW, which is 500 MW less than the current state demand for offshore wind in the area. Furthermore, Alternative F combined with the Alternative D2 layout would not be able to meet existing announced demand as described in Chapter 1.
- Independent of the Proposed Action, and after publication of the DEIS, Vineyard Wind and other Rhode Island and Massachusetts offshore wind leaseholders have committed to implementing a 1 x 1 nautical mile WTG grid layout in east-west orientation (equivalent to Alternative D2) in response to stakeholder feedback. The RI and MA Lease Area developers' agreement was reached in order to avoid irregular transit corridors. This agreement alone has resulted in significant reductions in the area available for offshore wind development. BOEM recognizes that implementation of Alternative F could further erode project economics and viability.
- The potential construction delays described above could create more overlap with other future offshore wind projects' construction schedules, potentially leading to increased overall impacts on resources that are sensitive to overlapping construction activities. In addition, comments received on the SEIS stated that delays of the proposed Project's commercial operation date could also jeopardize the achievement of Massachusetts' clean energy and climate goals and the promise of substantial ratepayer cost savings as well as Connecticut's energy goals.

In addition, as described above, USCG's Final MARIPARS, published in May 2020, evaluated vessel traffic through the lease areas and recommended all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would pass one WTG on either side every 1 nautical mile when traveling north-south or east-west, and every 0.6 to 0.8 nautical mile when traveling northwest-southeast or northeast-southwest (USCG 2020b). The Final MARIPARS did not recommend implementation of a wider transit lane. In response to concerns of increased navigational safety risks due to all transiting traffic being funneled into a navigational safety corridor, the USCG stated that "the standard and uniform [1-nautical-mile] grid pattern…should alleviate… concerns [with compression and funneling traffic through relatively narrow lanes] by providing vessels with sufficient spacing and multiple options to transit safely through the array. If the entire MA/RI WEA is developed consistent with such a grid pattern, mariners could choose among the many resulting navigation safety corridors to safely navigate through the entire MA/RI WEA" (USCG 2020b).

A transit lane alternative was eliminated in the DEIS because locations previously discussed did not intersect the WDA. Since the transit lane now proposed by RODA does intersect the WDA, the previous reason for elimination is

[20] The RI and MA Lease Areas are comprised of OCS-A 0486 Revolution Wind, OCS-A 0517 South Fork, OCS-A 0500 and 0487 Sunrise Wind, OCS-A 0500 Bay State Wind, OCS-A 501 Vineyard Wind, OCS-A 0520 Equinor Wind, OCS-A 0521 Mayflower Wind, and OCS-A 0522 Liberty Wind.

no longer applicable. For these reasons, BOEM elected to fully evaluate RODA's proposed layout in the SEIS and in this FEIS.

2.1.6. Alternative G—No Action Alternative

As described in Table 2.1-1, under the No Action Alternative, BOEM would not approve the proposed Project activities of the Vineyard Wind 1 Offshore Project. No federal other permits and/or authorizations for this proposed Project would be issued.

2.2. Resources, Issues, and Mitigation Measures

Based on previous environmental reviews, subject-matter expert input, consultation efforts, and public involvement to date for proposed offshore wind development activities, BOEM considered the following resources to be potentially affected by the proposed Project: Coastal Habitats; Benthic Resources; Finfish, Invertebrates, and Essential Fish Habitat; Marine Mammals; Sea Turtles; Demographics, Employment, and Economics; Environmental Justice; Cultural, Historical, and Archaeological Resources; Recreation and Tourism; Commercial Fisheries and For-Hire Recreational Fishing; Navigation and Vessel Traffic; Other Uses (Marine Minerals, Military Use, Aviation, Offshore Energy); Air Quality; Water Quality; Birds; Bats; Terrestrial and Coastal Fauna; and Land Use and Coastal Infrastructure. The baseline conditions of these resources, and the potential impacts of the Proposed Action and other alternatives on them, are evaluated in Chapter 3 and Appendix A.

2.2.1. Mitigation Identified for Analysis in the Environmental Impact Statement

As stated in Section 2.1, as part of the Proposed Action, Vineyard Wind has committed to voluntarily implement measures to avoid, reduce, or monitor impacts (summarized in COP Volume III Table 4.2-1 and 4.2-1; Epsilon 2020b) on the resources discussed in Chapter 3 and Appendix A. For purposes of assessing impacts in this FEIS, BOEM considers the voluntary measures presented in the COP to be part of the Proposed Action and action alternatives. BOEM, in consultation with cooperating agencies, may select any of the mitigation measures identified and assessed in this FEIS in addition to the alternative or combination of alternatives it selects in the ROD, and may select additional measures arising from ongoing cooperating agency consultation or during review of the COP. Additionally, compliance with applicable laws and regulations by Vineyard Wind and BOEM may require additional measures or changes to the measures described in this FEIS. This FEIS analyses measures identified to date from consultation with cooperating agencies, but additional or modified measures may arise before consultation is completed—for example consultation under the MMPA or the MSA. Measures considered in this FEIS are listed in Appendix D. Any measures that are required as conditions of COP approval would be incorporated and documented in the ROD. All mitigation measures included in Appendix D have been included in the evaluation of resource impacts in Chapter 3 and Appendix A; if the COP is approved or approved with conditions, mitigation measures that are required under various consultations and permits (e.g., ESA and MMPA) will be included in an attachment to the ROD. In addition, BOEM will continue to work with cooperating agencies in the implementation of any outstanding recommendations or measures.

In the ROD, BOEM would explain what the decision was, how it was made, and what mitigation measures are imposed to lessen adverse impacts of the Proposed Action, among the other requirements of Section 1505.2. The ROD would also include a monitoring and enforcement program to be adopted along with the mitigation measures that would be required of Vineyard Wind. Thus, the ROD would document all terms and conditions of COP approval and would compel compliance with or execution of identified mitigation and monitoring measures (40 C.F.R. § 1505.3). Vineyard Wind would be required to certify compliance with certain terms and conditions, as required under 30 C.F.R. § 585.633(b).

2.3. Non-Routine Activities and Low Probability Events

Non-routine activities and low-probability events associated with the proposed Project could occur during the construction, operation, maintenance, or decommissioning of the proposed Project. Examples of such activities or events could include corrective maintenance activities; collisions or allisions (a vessel striking a stationary object) between vessels, vessels and WTGs or ESPs, or vessels and marine life; cable displacement or damage by anchors or fishing gear; chemical spills or releases; severe weather and other natural events; and/or terrorist attacks. These activities or events are impossible 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. Vineyard Wind anticipates stocking spare parts and having ample workforce available for addressing corrective maintenance activities if required.
- *Collisions and allisions:* These could result in spills (described below), injuries, or fatalities to wildlife and injuries or fatalities (addressed in Chapter 3 and Appendix A). 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;
  - High vessel traffic areas were excluded from the Massachusetts WEA;
  - National Oceanic and Atmospheric Administration (NOAA) vessel-strike guidance would be implemented, as practicable;
  - The proposed spacing between WTGs and other facility components;
  - The lighting and marking plan that would be implemented, as described above; and
  - The inclusion of proposed-Project components on nautical charts.
- *Cable displacement or damage by vessel anchors or fishing gear:* This could result in safety concerns and economic damages to vessel operators and may require corrective action by Vineyard Wind. However, such incidents are unlikely to occur because the proposed Project would be indicated on navigational charts and the cable would be buried at least 5 feet (1.5 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. Vineyard Wind does not expect spills from vessels to occur, but if one did occur, it would likely be small and expected to dissipate rapidly and evaporate within days. Vineyard Wind would be expected to comply with USCG and Bureau of Safety and Environmental Enforcement regulations relating to prevention and control of oil spills. In addition, spill impacts would be minimized by adherence to the Oil Spill Response Plan included in COP Appendix I-A (Volume I; Epsilon 2020a). Additional information related to potential spills can be found in the Navigational Risk Assessment (NRA) (COP Volume III, Appendix III-I; Epsilon 2020b), Bejarano et al. (2013), and Section A.8.2 in Appendix A. Onshore, releases could potentially occur from construction equipment and/or HDD activities. Vineyard Wind would conduct refueling and lubrication of stationary equipment in a manner that protects coastal habitats from accidental spills. Additionally, a Spill Prevention, Control, and Countermeasure Plan would be prepared in accordance with applicable requirements and would outline spill prevention plans and measures to take to contain and clean up spills that may occur.
- *Severe weather and natural events:* As described above, Vineyard Wind designed the proposed Project components to withstand severe weather events.[21] The WTGs would be designed to endure sustained wind speeds of up to 112 mph (182.2 kph) and gusts of 157 mph (252.7 kph). WTGs would also automatically shut down when wind speeds exceed 69 mph (111 kph). In addition, the structures would be designed for maximum wave heights greater than 60 feet (18.3 meters) (Vineyard Wind 2018b). 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 and Appendix A, during construction activities. While highly unlikely, structural failure of a WTG (i.e., loss of a

[21] Appendix E provides hurricane magnitude and frequency information for severe weather that has occurred in Massachusetts and the WDA.

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 and Appendix A.

- *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.

2.4. Summary and Comparison of Impacts by Alternatives

Table 2.4-1 summarizes and compares the impacts under each action alternative. Tables 3-1 and 3-2 in Appendix B provide definitions for **negligible**, **minor**, **moderate**, and **major** impacts. Resources with overall adverse impact ratings no greater than **minor** (green) are analyzed in Appendix A and the more impacted resources are analyzed in Chapter 3. All impact levels are assumed to be adverse unless specified as beneficial. Where impacts are presented as multiple levels, the table color represents the most adverse level of impact. Although the detailed description of potential impacts could vary across action alternatives, as described in Chapter 3 and Appendix A, many of the differences in potential impacts across alternatives do not warrant differences in the impact ratings determined based on the definitions used.

Under Alternative G (No Action), any specific environmental and socioeconomic impacts, including benefits, associated with the proposed Project would not occur; however, impacts could occur from other no action activities as described in Chapter 3 and Appendix A.

2.5. Preferred Alternative

The Council on Environmental Quality (CEQ) NEPA regulations require the identification of a preferred alternative in the FEIS.[22] 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 implement the preferred alternative.

[22] Identification of a preferred alternative for an FEIS is required by both the CEQ NEPA regulations issued on July 16, 2020 (85 Fed. Reg. 43304–43376) and the regulations in place previously (CEQ 2005). To note, the new regulations provide that the “regulations in this subchapter apply to any NEPA process begun after September 14, 2020. An agency may apply the regulations in this subchapter to ongoing activities and environmental documents begun before September 14, 2020.” (85 Fed. Reg. 43372-73 [July 16, 2020]; 40 C.F.R. § 1506.13). The Vineyard Wind NEPA process is well underway, and BOEM has chosen to follow the previous long-standing CEQ NEPA regulations on this and other matters concerning the Vineyard Wind EIS as well as the existing Department of the Interior NEPA regulations that are based on the previous CEQ NEPA regulations (43 C.F.R. Part 46).

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Table 2.4-1: Impacts by Action Alternative Resource Affected [a]

Resources	Proposed Action	Alternative C	Alternative D1	Alternative D2	Alternative E	Alternative F	Preferred Alternative
Coastal Habitats: *Project Impacts*	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**
Coastal Habitats: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Benthic Resources: *Project Impacts*	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**
Benthic Resources: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Finfish, Invertebrates, and Essential Fish Habitat: *Project Impacts*	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**	**Negligible to moderate** and **moderate beneficial**
Finfish, Invertebrates, and Essential Fish Habitat: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Marine Mammals: *Project Impacts*	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**
Marine Mammals: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Sea Turtles: *Project Impacts*	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially minor **beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**	**Negligible** to **moderate** and potentially **minor beneficial**
Sea Turtles: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Demographics, Employment, and Economics: *Project Impacts*	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**
Demographics, Employment, and Economics: *Planned Actions with Project Impacts*	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**	**Minor** and **moderate beneficial**
Environmental Justice: *Project Impacts*	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects	**Negligible** to **major**, depending on the specific community affected, and **beneficial** effects
Environmental Justice: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Cultural, Historical, and Archaeological Resources: *Project Impacts*	**Negligible** to **major**, depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected	**Minor** to **major,** depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected	**Negligible** to **major**, depending on the specific resource affected
Cultural, Historical, and Archaeological Resources: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Recreation and Tourism: *Project Impacts*	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**	**Negligible** to **moderate** and **negligible** to **minor beneficial**
Recreation and Tourism: *Planned Actions with Project Impacts*	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**	**Moderate** and **minor beneficial**
Commercial Fisheries and For-Hire Recreational Fishing: *Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Commercial Fisheries and For-Hire Recreational Fishing: *Planned Actions with Project Impacts*	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**
Navigation and Vessel Traffic: *Project Impacts*	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**	**Negligible** to **moderate**
Navigation and Vessel Traffic: *Planned Actions with Project Impacts*	**Major**	**Major**	**Major**	**Moderate**	**Major**	**Moderate to Major**	**Moderate**

Resources	Proposed Action	Alternative C	Alternative D1	Alternative D2	Alternative E	Alternative F	Preferred Alternative
Other Uses: *Project Impacts*	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **minor;** Scientific research and surveys: **major**
Other Uses: *Planned Actions with Project Impacts*	Military and national security: **minor** for most but **major** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **major** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **major** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **major** for search and rescue activities; Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **major** for search and rescue activities, except for **moderate** with combined with Alternative D2 Aviation and air traffic: **minor;** Cables and pipelines: **negligible;** Radar systems: **moderate;** Scientific research and surveys: **major**	Military and national security: **minor** for most but **moderate** for search and rescue activities, Aviation and air traffic: **minor** Cables and pipelines: **negligible** Radar systems: **moderate** Scientific research and surveys: **major**
Air Quality: *Project Impacts*	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**	**Negligible to minor** and **minor beneficial**
Air Quality: *Planned Actions with Project Impacts*	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**
Water Quality: *Project Impacts*	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**	**Negligible** to **minor**
Water Quality: *Planned Actions with Project Impacts*	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**
Birds: *Project Impacts*	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**	**Negligible** to **minor** and potentially **minor beneficial**
Birds: *Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Bats: *Project Impacts*	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Bats: *Planned Actions with Project Impacts*	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Terrestrial and Coastal Fauna: *Project Impacts*	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**	**Minor**
Terrestrial and Coastal Fauna*: Planned Actions with Project Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Land Use and Coastal Infrastructure: *Project Impacts*	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**	**Negligible** to **minor** and **negligible** to **minor beneficial**
Land Use and Coastal Infrastructure: *Planned Actions with Project Impacts*	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**	**Minor** and **minor beneficial**

[a] As specified above, the Proposed Action (Alternative A) and action alternatives only contemplate the Covell's Beach landfall and onshore route. Therefore, Alternative B is no longer evaluated as an action alternative in this FEIS.

Impact rating colors are as follows: orange = **major**; yellow = **moderate**; green = **minor**; light green = **negligible** or **beneficial** to any degree. 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. The details of particular impacts and explanations for ranges of impact levels are found in each resource section.

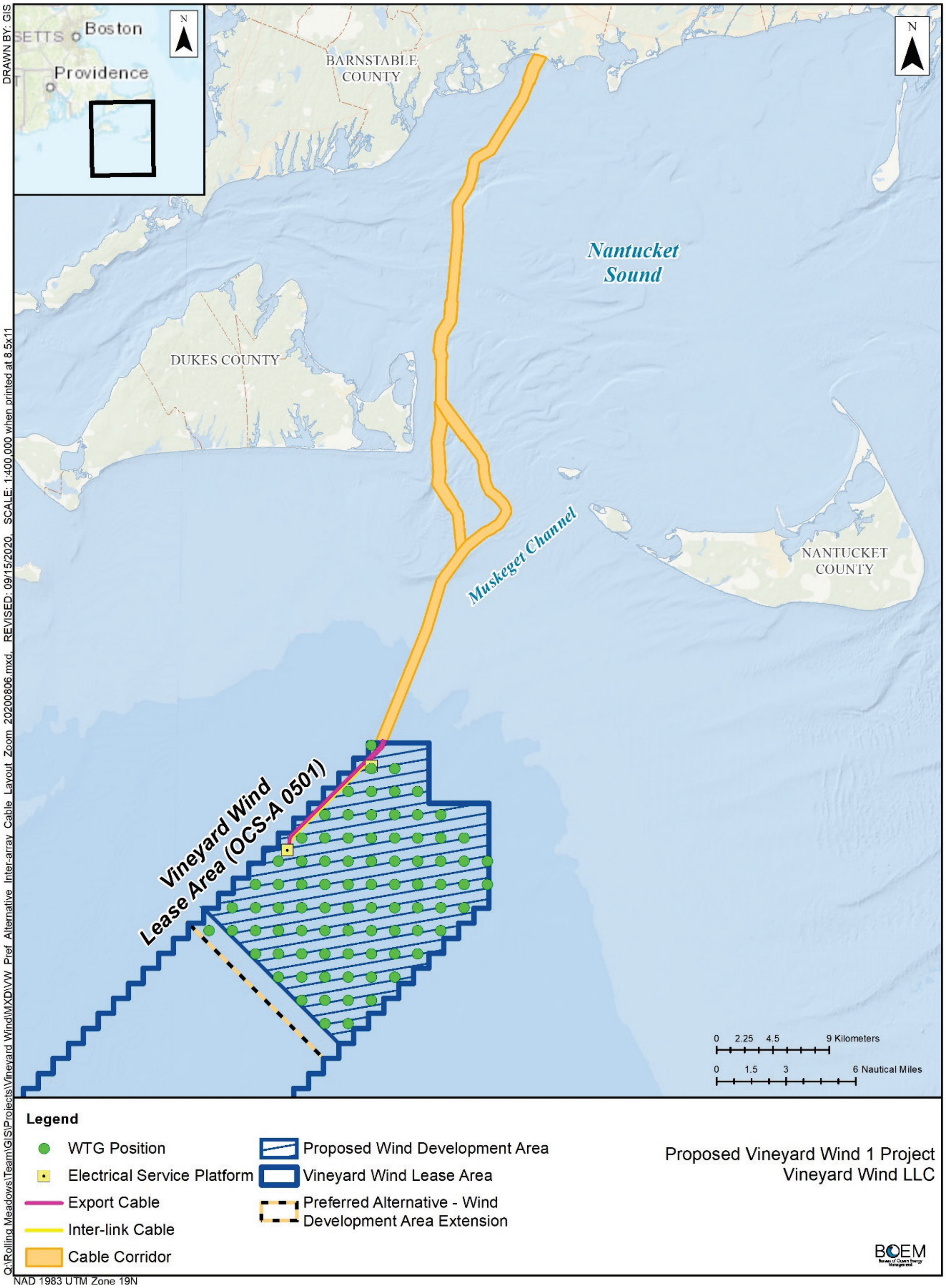
BOEM has identified the combination of Alternatives C (No Surface Occupancy in the Northernmost Portion of the Project Area Alternative), D2 (East-West and One-Nautical-Mile Turbine Layout), and E (Reduced Project Size Alternative) as its preferred alternative (Preferred Alternative) (Figure 2.5-1).[23] Alternative E would limit the proposed Project to 57 to 84 WTGs.[24] The Preferred Alternative would entail the construction, operation, maintenance, and eventual decommissioning of an 800 MW large-scale commercial wind energy facility consisting of no more than 84 WTGs on the OCS offshore Massachusetts within the proposed WDA with the export cable making landfall at Covell's Beach. The Preferred Alternative would allow up to 84 turbines to be installed in 100 of the 106 proposed locations and would prohibit the installation of WTGs in 6 locations in the northernmost portion of the WDA. The Preferred Alternative would require the WTGs to be arranged in a north-south and east-west orientation with a minimum spacing of 1 nautical mile between them, and 0.6- to 0.8-nautical-mile-wide lanes when traveling northwest-southeast or northeast-southwest. The Preferred Alternative would conform to the design parameter ranges outlined in the Vineyard Wind COP, which includes measures that Vineyard Wind has voluntarily committed to implement to avoid or reduce impacts, except that cabling is likely to exceed the COP design parameters. Impacts from such additional cabling have been considered within this FEIS.

BOEM's Preferred Alternative includes mitigation and monitoring measures to avoid or reduce impacts on existing ocean uses and environmental and socioeconomic resources associated with construction, operation, and maintenance activities across the various resource areas analyzed in this document. Table D-1 in Appendix D contains resource-by-resource details on mitigation and monitoring measures considered for the Proposed Action, other action alternatives, and BOEM's Preferred Alternative. Impacts from BOEM's Preferred Alternative have been determined to be within the scope of effects analyzed in the Final NMFS Biological Opinion (BO) and in the proposed NMFS IHA. If a mitigation measure is incorporated in this FEIS analysis as a result of a mandated consultation or permit (such as NMFS BO or MMPA Incidental Harassment Authorization [IHA]), the measure will be included as a condition in the ROD.

Chapter 3 and Appendix A include a detailed discussion of potential impacts on each resource for each of the alternatives. Each resource area in Chapter 3 and Appendix A includes a subsection called "Summary of Impacts of the Preferred Alternative on [insert resource area name]." Under this subsection, the potential impacts of the Preferred Alternative are summarized from the information presented under the alternative sub-sections for the action alternative. Table 2.4-1 summarizes the impacts associated with the Preferred Alternative on each individual resource area assessed in Chapter 3 and Appendix A.

[23] On June 26, 2020, Vineyard Wind informed BOEM that it is no longer pursuing the New Hampshire Avenue landing site. Although the New Hampshire Avenue site was included in the COP, Vineyard Wind has obtained all of the state and local permits necessary to bring the cable onshore at the Covell's Beach landing site. Further, Vineyard Wind has indicated it would remove this landfall from its COP, which would eliminate Alternative B. Therefore, Alternative B is equivalent to the Proposed Action and not discussed or considered further in this document. As stated in the DEIS, the alternatives are not mutually exclusive, and BOEM could "mix and match" multiple listed alternatives to result in a preferred alternative so long as crucial design parameters are compatible. Because Alternatives C, D2, and E are compatible, BOEM has selected this combination as the Preferred Alternative.

[24] On February 28, 2019, the Rhode Island Coastal Resources Management Council concurred with the Coastal Zone Management Act consistency certification filed by Vineyard Wind. Pursuant to the council's concurrence letter, Vineyard Wind will not install more than 84 WTGs to achieve an approximately 800 MW capacity project (CRMC 2019).



Note: The inter-array cable layout shown is an example, and the final layout and location of the cables would be located within the approved PDE. The up to 84 WTGs would be located within 100 of 106 locations presented as part of the Vineyard Wind PDE, and the cable route from the WDA to Covell's Beach would follow one of two options through Muskeget Channel.

Figure 2.5-1: Preferred Alternative Project Elements

3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter addresses the affected environment for each resource area and the potential environmental consequences to those resources from the alternatives described in Chapter 2. In addition, it addresses the impact of the alternatives when combined with other past, present, or reasonably foreseeable planned actions using the methodology and assumptions outlined the Chapter 1 and Appendix A. Impacts are defined as those occurring at the same time and place as the action as well as those that could occur later in time or at a different place, but are still reasonably foreseeable. BOEM assumes that the adverse and beneficial impacts of planned offshore wind projects, including the proposed Project, would probably be less if the total offshore wind power generating capacity assumed in Chapter 1 is not met.

Where information was incomplete or unavailable for the evaluation of reasonably foreseeable impacts analyzed in this chapter, BOEM identified that information and conducted its analysis in accordance with Section 1502.22 of the CEQ regulations. The findings of this assessment are presented in Appendix H.

Table A-4 in Appendix A provides expanded planned action scenarios quantitatively analyzing impacts (where feasible). The scenarios vary based on the geographic analysis area for a particular resource (Section 1.7.3 for additional detail). Table A-1 in Appendix A describes, and Figures A.7-1 through A.7-16 depict, the geographic analysis area for each resource. These geographic analysis area boundaries remain largely unchanged from the DEIS. Table A-1 in Appendix A explain the few changes that have occurred.

This FEIS uses a four-level classification scheme to characterize the potential impacts of the alternatives. Table 3-1 provides adverse and Table 3-2 provides beneficial impact levels for all biological, physical, and socioeconomic resources that the proposed Project and alternatives could potentially affect. BOEM subject matter experts have determined impact classification levels based on the facts and analysis in this FEIS and the documents it references. A range of impacts could be presented in the analysis of effects which is based on subject matter experts weighing the magnitude of the impact leaves and the pervasiveness of each IPF to determine an overall impact. Effects presented should be considered adverse unless the FEIS states that they are beneficial. In addition, this FEIS provides information related to the magnitude, duration, geographic extent, and frequency of potential impacts, as appropriate, to support impact determinations.

As stated previously, BOEM's analysis utilizes resource-specific assumptions in order to assess the most impactful scenarios for potential effects. Table 3-3 summarizes the maximum-case WTG scenarios applicable to each resource discussed in Chapter 3 and Appendix A.

The main subsections within this chapter are organized by resource. Within each resource, BOEM analyzes the effects of each alternative. This FEIS incorporates analyses and matters raised in comments received on the DEIS and SEIS, including the reasonably foreseeable offshore wind activities scenario and effects analysis, previously unavailable fishing data, a new transit lane alternative, and changes to the proposed Project from the SEIS.

No Action Alternative: The No Action Alternative sections include a description of the baseline conditions of the affected environment for each resource. This information comes from the COP (Epsilon 2018a, 2019c, 2020a, 2020b), government sources, public comments, and scientific literature and is used to assess the potential impacts of the alternatives. This FEIS analyzes impacts of ongoing activities (e.g., dredging, offshore disposal, fishing) and future non-offshore wind activities (e.g., expected increases in vessel traffic, mineral extraction) within the geographic analysis area. Next, the FEIS analyzes impacts of reasonably foreseeable offshore wind activities other than the proposed Project in the same geographic analysis area. Finally, each conclusion section states the anticipated combined impacts from ongoing and future activities (offshore wind and non-offshore wind). The analysis of impacts under the No Action Alternative assumes that best management practices (BMPs) described in the ROD for the 2007 *Final Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf* (MMS 2007b) will be implemented for future offshore wind activities. The BMPs are summarized in Table A-5 in Appendix A.

Depending on the size of the geographic analysis area for a particular resource, the Project may or may not affect the total amount of development expected in that area. To assist with the analysis, this FEIS divides resources into two categories.

- Resources with an "expansive" geographic area have an analysis area that either includes all of the RI and MA Lease Areas or is independent of all wind lease areas. In this case, the Massachusetts state demand that the Vineyard Wind 1 Project would fill, if approved, could still be met by other projects and could cause impacts on resources within the geographic analysis area. Overall impacts under the No Action Alternative could be similar in type and amount with or without the Proposed Action, although the exact impacts associated with meeting the Massachusetts state demand could vary due to temporal and geographic differences.
- Resources with a "restricted" geographic area have an analysis area including the WDA, at a minimum, and potentially other RI and MA Lease Areas, but excluding substantial portions of some leased and unleased areas. In this case, BOEM assumes that impacts on the resources are likely to be less if the No Action Alternative is chosen because development other than the Project to meet Massachusetts state demand would probably have less impact within the geographic analysis area defined for resource analysis.

Resources with an "expansive" area include the following:

- Finfish, Invertebrates, and Essential Fish Habitat (Section 3.3)
- Marine Mammals (Section 3.4)
- Sea Turtles (Section 3.5)
- Demographics, Employment, and Economics (Section 3.6)
- Environmental Justice (Section 3.7)
- Cultural Resources (Section 3.8)
- Recreation and Tourism (Section 3.9)
- Commercial Fisheries and For-Hire Recreational Fishing (Section 3.10)
- Navigation and Vessel Traffic (Section 3.11)
- Other Uses (Section 3.12)
- Birds (Appendix A, Section A.8.3)
- Bats (Appendix A, Section A.8.4)
- Land Use and Coastal Infrastructure (Appendix A, Section A.8.6)

Resources with a "restricted" area include the following:

- Benthic Resources (Section 3.2)
- Air Quality (Appendix A, Section A.8.1)
- Water Quality (Appendix A, Section A.8.2)

Terrestrial and Coastal Fauna (Appendix A, Section A.8.5) and Coastal Habitats (Section 3.1) resources have particularly small geographic analysis areas. Future offshore wind projects might impact these resources, but impacts on them are assessed qualitatively in this FEIS because whether there will be any impacts at all depends on unknown Project specifics. Furthermore, BOEM has assessed that the action alternatives would have no greater than overall **minor** adverse impacts on air quality, water quality, birds, and bats. To focus on the impacts of most concern, BOEM has placed analysis of these resources in Appendix A. Additionally, unless otherwise specified, all tables referenced in this chapter are included in Appendix B.

No impacts from the proposed Project would occur under the No Action Alternative, but impacts would occur from ongoing, future non-offshore wind, and future offshore wind activities (Tables 3.1-1, 3.2-1, 3.3-1, 3.4-1, 3.5-1, 3.6-1, 3.7-1, 3.8-1, 3.9-1, 3.10-1, 3.11-1, and 3.12-1). The No Action Alternative analysis assumes for the expansive areas noted above, that the energy demand that the Vineyard Wind 1 Project would fill (if approved) would likely be met by other projects in remaining areas of the Massachusetts, Rhode Island, and/or New York leases (if Vineyard Wind was not approved). Although the impacts from a substitute project may differ in location and time, depending on where and when offshore wind facilities are developed to meet the remaining demand, the nature of impacts and the total number of WTGs would be similar either with or without the Proposed Action. In other words, future offshore wind facilities capable of generating 9,404 MW could still be built in the RI and MA Lease Areas under the No Action Alternative, although none would be built before 2022. Therefore, the impacts on finfish, invertebrates, and EFH, marine mammals, sea turtles, demographics, employment, and economics, environmental justice populations, cultural resources, recreation and tourism, commercial fisheries and for-hire recreational fishing, navigation and vessel traffic, and other uses would be similar to those that would occur if the proposed Project were built, but the exact impacts would not be the same due to temporal and geographical differences.

For coastal habitats and benthic resources, the state demand that the Vineyard Wind 1 Project would have filled (if approved) could likely be met by other projects in the southern New England region. Considering the limited extent of the geographic analysis area for coastal habitats, only a small subset of potential future offshore wind activities have the potential to influence conditions within the analysis area (Table 3.1-1). Specifically, no RI or MA Lease Areas would overlap the coastal habitats geographic analysis area; given the locations of RI and MA Lease Areas and the COPs or other announced plans for offshore export cable routes, the only future offshore wind activities (other than the Proposed Action) that may reasonably be expected to lay cable in the geographic analysis area are Vineyard Wind 2 (OCS-A 0501 [southern portion]), Mayflower Wind (OCS-A 0521), a development by Equinor Wind US (OCS-A 0520), and Bay State Wind (OCS-A 0500). Of these, only Vineyard Wind 2 and Mayflower Wind have announced plans for cable routes in the geographic analysis area for coastal habitats. Vineyard Wind 2 intends to lay cable in close proximity to the OECC for the Proposed Action, and Mayflower Wind would lay cable somewhere between Martha's Vineyard and Muskeget Island, through Nantucket Sound, making landfall somewhere on Cape Cod. Because precise cable corridors are not known for any specific project, the potential impacts of future offshore wind activities (other than the Proposed Action) on coastal habitats are not reasonably quantifiable. The analysis assumes that state offshore wind power demand could not be accommodated entirely by projects in the geographic analysis area for benthic resources, and the analysis does not include the impacts associated with the proposed Project. The analysis is limited to reasonably foreseeable offshore wind developments for which at least 5 percent of the wind lease area overlaps the geographic analysis area, namely OCS-A 0500, OCSA 0501, OCS-A 0520 and OCS-A 0521 (Figure A.7-3). The specific routes of unannounced OECCs are not reasonably foreseeable; therefore, the analysis considers cables that would originate only from the wind lease areas listed above. In the absence of the Proposed Action, BOEM assumes that the total generating capacity of offshore wind facilities in the geographic analysis area for benthic resources would be 2,655 MW, which is 800 MW less than if the Proposed Action were approved. For the most part, the incremental impacts of the Proposed Action would be additive with those of ongoing activities, future non-offshore wind activities, and other future offshore wind activities.

The No Action Alternative analysis addresses reasonably foreseeable offshore wind projects (or portions of projects) that fall within the geographic analysis area for that resource and considers the assumptions included in Section 1.7 and Appendix A.

Action Alternatives: The remainder of this chapter analyses the impacts of the action alternatives alone[1] and in combination with the ongoing activities, future non-offshore wind activities, and future offshore wind activities described under the No Action Alternative. As part of the proposed Project, Vineyard Wind has committed to voluntarily implement measures to avoid, reduce, or mitigate impacts on the resources discussed in Chapter 3 and Appendix A. Those mitigation and monitoring measures are summarized in the Vineyard Wind COP, Volume III, Table 4.2-1 and 4.2-2 (Epsilon 2020b). BOEM considers those measures that Vineyard Wind has committed to in the Vineyard Wind COP to be part of the proposed Project. BOEM may select alternatives or require additional mitigation or monitoring measures to further protect and monitor affected resources. The mitigation and monitoring measures that Vineyard Wind has committed to implement as well as those that may result from reviews under applicable statutes are described in Appendix D, Table D-1, and are incorporated in this analysis.

The proposed-Project specifics may vary within the PDE and includes things such as the number of WTGs and their spacing within the WDA, spatial coverage of the overall WDA, variations in the planned cable layout, and construction schedule. This variation would impact the magnitude and spatial extent of impacts. The impacts analysis below assumes a maximum-case scenario (Appendix G). The actual specifics of the proposed Project may

[1] The DEIS and SEIS contemplated two OECRs, with alternative options within each route; however, since the publication of the SEIS, Vineyard Wind has stated all necessary state and local permits for the Covell's Beach landfall location have been acquired. Therefore, the Proposed Action (Alternative A) and action alternatives only contemplate the Covell's Beach landfall and onshore route. Therefore, Alternative B is no longer evaluated as an action alternative in this FEIS. The identification of the action alternatives will maintain the same lettering (Pachter, Pers. Comm., June 26, 2020).

be less impacting but are not likely to result in different conclusions about impacts than those described below in this chapter.

3.1. Coastal Habitats

3.1.1. No Action Alternative and Affected Environment

This section describes the baseline conditions in the geographic analysis area for coastal habitats as described in Table A-1 in Appendix A and shown on Figure A.7-2, namely, all lands and waters within the 3-nautical-mile seaward limit of Massachusetts' territorial sea to 100 feet (30.5 meters) landward of the first major land transportation route encountered (a road, highway, rail line, etc.) that is within a 1-mile (1.6-kilometer) buffer of the OECC. Table 3.1-1 describes baseline conditions and the impacts based on the IPFs assessed of ongoing and future activities other than offshore wind, which is discussed below. Pursuant to scoping comments from NMFS (April 7, 2018), BOEM prepared an expanded EFH assessment for Alternative A (BOEM 2019e), as well as a new addendum to evaluate changes to the PDE and the new Alternative F (BOEM 2020e); this section incorporates the entire EFH assessment by reference and summarizes and discusses some of the EFH assessment's key findings that apply to coastal habitats, as defined below. Section 3.3 provides a broader discussion of impacts to EFH, finfish, and invertebrates (including shellfish); Section 3.2 discusses benthic resources; and Section A.8.5 in Appendix A discusses terrestrial habitat.

Massachusetts Office of Coastal Zone Management (CZM) manages coastal habitat within the geographic analysis area for coastal habitats. Massachusetts CZM defines the coastal zone as the area that "includes the lands and waters within the seaward limit of the state's territorial sea [3 nautical miles from land] to generally 100 feet beyond (landward of) the first major land transportation route encountered (a road, highway, rail line, etc.)" (CZM 2011). The coastal habitats within the geographic analysis area are limited to portions of the OECC and the landfall site (Figures 2.1-1 and 2.1-2). The WDA and the southernmost portion of the OECC (approximately 14 miles [22.5 kilometers]) are beyond the seaward limits of the territorial seas of Massachusetts and Rhode Island.

Detailed data in the geographic analysis area for coastal habitats are mostly limited to the OECC. The OECC can be subdivided into five geological zones based on the physical characteristics and benthic substrates observed in Vineyard Wind's site assessment surveys. Coastal habitat is present in Zones 2, 3, 4, and 5 (COP Table 2.1-4 and COP Figure 2.1-11, Volume II-A; Epsilon 2018a). Typically, water depth in the geographic analysis area for coastal habitats ranges from 0 to 49.2 feet (15 meters), but can be as deep as 131.2 feet (40 meters). Benthic grab samples and underwater video transects collected during 2016–2017 biological surveys helped determine habitat type (COP Volume II-A, Section 5; Epsilon 2018a). Seafloor habitat types, based on the habitat categories defined in COP Table 5.1-1 (Volume II-A; Epsilon 2018a), are primarily sandy, but vary across geographical zones. Zone 2 is subject to high currents and exhibits a mainly sand and gravel bed with ripples and sand waves mostly 3.3 to 4.9 feet (1 to 1.5 meters) high. Some Zone 2 habitats include biogenic structures (e.g., burrows and sessile unshelled organisms), shell aggregates, or gravel-cobble beds. Zone 3 exhibits mostly flat sand and silt substrate with ripples and sand waves 3.3 to 6.6 feet (1 to 2 meters) high; biogenic structures are less common. Zone 4 is also primarily flat sand and silt. A minority of areas include small sand waves, shell aggregates, or gravel-cobble beds. Zone 5 is subject to very high currents and exhibits coarser bed material with some hard-bottom patches and sand waves. The sand waves are mostly 6.6 to 13.1 feet (2 to 4 meters) high, but range up to 22.9 feet (7 meters) high. Zone 5 also includes shell aggregates, cobble beds with and without sponge cover, sulfur sponge (*Cliona celata*) beds, and a few isolated boulders.

Seafloor habitats can also be classified more broadly as biogenic structures, hard bottom, complex seafloor, and other, which would include the majority of flat sand and mud habitat in the OECC (Attachment E in Epsilon 2018b). Hard bottom in the geographic analysis area for coastal habitats typically consists of a combination of coarse deposits such as gravel, cobble, and boulders in a sand matrix. These coarse deposits form a stable surface over which sand waves forced by tidal currents periodically migrate. Certain hard-bottom areas also include piles of exposed boulders, but no bedrock outcrops are present in the OECC. Complex seafloor in the OECC consists of bedforms such as rugged fields of sand waves; although these mobile habitats are less amenable to benthic macroinvertebrates, they may be attractive to finfish. Maps delineating these habitats based on the results of a 2018 survey reported in Attachment E of Epsilon 2018b are shown on Figures E.3-1a through E.3-1e of Appendix E. In addition, CZM has defined a "hard/complex bottom" habitat (CZM 2014; Commonwealth of Massachusetts 2015), which would generally include all of the biogenic structures, hard bottom, and complex seafloor in the OECC. Section 3.2 discusses benthic organisms associated with these types of habitats. Throughout this section, the coastal habitat types discussed are based on those used by CZM (2014), the Commonwealth of Massachusetts (2015), and COP Volume II-A, Section 5 (Epsilon 2018a) and do not necessarily align with NMFS classifications of hard, complex, or sensitive habitats as pertaining to EFH. Section 3.3 and the EFH assessment (BOEM 2019e, 2020b) discuss habitats from the perspective of finfish, invertebrates, and EFH. Within most of the OECC, the substrate is generally flat with unconsolidated sand and silt substrates, with the exception of the areas near Zone 5, which are more coarse and diverse (COP Figure 5.1-2, Volume II-A; Epsilon 2018a). In addition, there are biogenic structures (e.g., burrows, depressions, cerianthid anemones, and hydroid patches) along the OECC leading to the Covell's Beach landfall site.

"Special, sensitive, and unique" (SSU) habitats (living bottom, hard/complex bottom, eelgrass [*Zostera marina*] areas, and marine mammal habitats) are considered high priorities for avoidance if possible. Vineyard Wind's cable corridor survey data from 2017 were compared to existing data to assess the potential for SSU habitats in the immediate vicinity of the proposed OECC (COP, Volume II-A; Epsilon 2018a). The proposed OECC and historically mapped sensitive areas provided by Massachusetts are shown on COP Figure 5.2-1 (Volume II-A; Epsilon 2018a). Vineyard Wind routed the proposed OECC to avoid sensitive habitat to the greatest extent practicable (Figure 3.1-1 and Figures E.3-1a to E.3-1e). The areas of habitats within 328 feet (100 meters) of the offshore export cable centerline are provided in Table 3.1-2.

Although there were a few targeted surveys between 2016 and 2018 (COP Volume II-A, Appendix II-H; Epsilon 2018a), there were no observations of living bottom (coral, macroalgae, mussels, serpulid worms, sabellariid worms, or other biogenic reef structures) in the OECC, with the exception of a single slipper limpet reef in the eastern OECC, which is no longer under consideration (COP Volume III, Sections 6.5.1.1 and 6.5.1.3, Epsilon 2020b; Volume II-A, Appendix II-H, Epsilon 2018a; and Pachter, Pers. Comm., June 26, 2020). The next closest known living bottom is a patch of stony cup coral (*Astrangia* sp.) in Zone 3, approximately 5.6 miles (9 kilometers) west of the OECC.

Vineyard Wind's survey data indicate hard-bottom habitat exists in portions of the OECC. This habitat type provides attachment sites for sessile benthic organisms, supports fish because the larger boulders and sponges rise above the seabed and are resistant to movement by currents, and supports other ecosystem functions, even where the hard-bottom habitat consists of low-relief pebbles. The Muskeget Channel area includes several pebble-cobble-sponge habitats and other hard/complex bottom habitats.

Eelgrass is a marine flowering plant that lives below the surface in less than 16.4 feet (5 meters) of water. Eelgrass beds provide (1) nursery ground and refuge for commercially important organisms, such as bay scallops (*Argopecten irradians*), flounders, striped bass (*Morone saxatilis*), tautog (*Tautoga onitis*), and seahorses; (2) habitat and food for waterfowl, shellfish, and finfish; and (3) sediment and shoreline stabilization (Heck et al. 1989). No evidence of eelgrass was detected in the sonar data or the underwater video transects inside the OECC, although there are eelgrass beds nearby (COP Figure 6.4-1, Volume III; Epsilon 2020b; BOEM 2019e). Section 3.3 discusses EFH and eelgrass beds. Hard/complex bottom habitat and an eelgrass bed are located in the vicinity of Spindle Rock, approximately 0.4 mile (0.6 kilometer) offshore of Covell's Beach.

The lack of any major river in the area to discharge water and sediment contributes to the relative consistency of local geology and coastal habitats over time. Flat sand beds are regionally common, locally abundant, and not expected to change significantly over time. Sand waves are locally abundant and are mobile over the course of days to years. There is often significant patchiness and sample-to-sample variability in habitats and benthos across space and time (MMS 2009).

Strong tidal currents near Muskeget Channel lead to more temporal variability, as each tidal cycle rearranges the finer substrates in the area. BOEM expects this process to be in a state of dynamic equilibrium over the coming decades. In areas with moderate current outside Muskeget Channel, sand waves naturally migrate across the seafloor.

Hard/complex bottom habitats are less common in the region. Historical maps of hard/complex bottom (CZM 2014; Commonwealth of Massachusetts 2015) indicated its presence in all of Muskeget Channel proper. In addition, surveys conducted in 2017 and 2018 (COP Volume II-A and Appendix II-H; Epsilon 2018a) found hard/complex bottom covering much of the Muskeget area. The areas of each coastal habitat type present along the OECC, as defined above, are shown in Table 3.1-2.

Development, commercial fishery activities, and tourism in the area could affect the sensitive habitats (e.g., hard/complex bottom and eelgrass beds) in the geographic analysis area for coastal habitats. Eelgrass beds in this region cover much less area than historically estimated (Cape Cod Commission 2011). A long-term study of eelgrass beds in Massachusetts reported a decline in coverage at 30 of the 46 sites, with a total loss of 20.6 percent between 1994 and 2007 (Costello and Kenworthy 2011). Eelgrass beds are threatened by anthropogenic activities, and declines in this habitat have been correlated with "physical disturbances (i.e., dredging, construction, shell fishing, propeller damage from boating), turbidity (i.e., topsoil runoff, activities that re-suspend sediments), pollution, and most notably, eutrophication as a result of nutrient loading" (CCS 2017).

Landward of the intertidal zone, coastal habitat in the geographic analysis area for coastal habitats is mostly a mixture of sandy beaches, rocks, and developed spaces. Coastal habitats on Martha's Vineyard and Chappaquiddick Island also include sand dune habitats, salt ponds, salt marshes, and scattered maritime forest. Sandy beaches in these areas are subject to erosion and vulnerable to the effects of projected climate change and relative sea-level rise (Roberts et al. 2015). Mainland coastal habitat in the geographic analysis area for coastal habitats mostly consists of sandy beach and dune vegetation; much of this is developed for public beach and private residences (Thieler et al. 2013). Development is likely to continue as the resident and vacationer populations expand.

Coastal habitats in the geographic analysis area (as defined in CZM (2014), Commonwealth of Massachusetts [2015], and COP Volume II-A, Section 5 [Epsilon 2018a]) are mostly relatively stable, although there is variability across space and time. Sand waves are mobile over the course of days to years. Eelgrass habitats in this region are in decline (Costello and Kenworthy 2011). Sandy beaches in these areas are subject to erosion and are vulnerable to the effects of projected climate change and relative sea level rise (Roberts et al. 2015). The shoreline is partially developed with residences, and this development is likely to continue. Coastal habitats are subject to pressure from ongoing activities, especially those that involve anchoring, seabed profile alterations, sediment deposition and burial, gear utilized for bottom trawling and dredge fishing, and climate change. The greatest concerns regarding potential impacts on coastal habitats are potential impacts on SSU habitats, especially living bottom, hard/complex bottom, eelgrass beds, and marine mammal habitats.

Vessel anchoring affects coastal habitats in the immediate area where anchors and chains meet the seafloor. Dredging for navigation, marine minerals extraction, and/or military uses disturbs swaths of seafloor habitat, leading to seabed profile alterations and sediment deposition in coastal habitats. Gear utilized for bottom trawling and dredge fishing results in seabed disturbances that are much more frequent and greater in spatial extent than those caused by other bottom-directed IPFs such as pipeline trenching, submarine cable emplacement, or sediment dredging. Climate change, including ocean acidification, ocean warming, and sea-level rise, also affects coastal habitats. All of these ongoing impacts will continue regardless of the offshore wind industry.

3.1.1.1. Future Offshore Wind Activities (without Proposed Action)

BOEM expects future offshore wind development activities would affect coastal habitat through the following primary IPFs.

Accidental releases: Accidental releases may increase as a result of future offshore wind activities. Section A.8.2 discusses the nature of releases anticipated. 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 fuel/fluids/hazmat have the potential to cause contamination of habitats and harm to the species that build biogenic coastal habitats (e.g., eelgrass, oysters, mussels, slipper limpets [*Crepidula fornicata*], salt marsh cordgrass [*Spartina alterniflora*]), either from the releases themselves and/or cleanup activities. The greatest risk of accidental releases in coastal habitats would be related to transportation of crews and equipment during construction and operations, as well as accidental releases from any nearshore activities associated with transmission cable installation. Accidental releases from offshore structures and offshore vessels would likely not reach coastal habitats.

Onshore, the use of heavy equipment could result in releases of fuel and lubricating and hydraulic oils during equipment use or refueling.

Trash and debris may be released by vessels during construction, operations, and decommissioning. BOEM assumes all vessels will comply with laws and regulations to minimize releases. In the event of a release it would be an accidental, small event in the vicinity of work areas. There does not appear to be evidence that the volumes and spatial/temporal extent of accidental releases of trash and debris would have any impact on coastal habitats.

The overall impacts of accidental releases on coastal habitats are likely to be localized, short-term, and to result in little change to coastal habitats. As such, accidental releases from future offshore wind development would not be expected to appreciably contribute to overall impacts on coastal habitats.

Anchoring: Increased anchoring may occur in the geographic analysis area for coastal habitats during survey activities and during the construction and installation of offshore export cables. The resulting impacts on coastal habitats would include temporarily increased turbidity levels and the potential for contact to cause physical damage to coastal habitats. For example, anchors could topple boulder piles and spread them out into small boulder fields with less vertical relief and structural complexity than existed before. Anchoring in eelgrass could kill or uproot patches of eelgrass, which may require years to recover. All impacts would be localized; turbidity would be temporary; physical damage could be long-term to permanent if it occurs in eelgrass beds or hard-bottom habitat.

EMF: An electromagnetic field (EMF) would emanate from any operating transmission cables in the geographic analysis area for coastal habitats. Sections 3.2 and 3.3 discuss the nature of potential effects. Submarine power cables in the geographic analysis area for coastal habitats are assumed to be installed with appropriate shielding and burial depth to reduce potential EMF resulting from cable operation to low levels. EMF of any two sources would not overlap because developers typically allow at least 330-foot (100-meter) spacing between cables. EMF strength diminishes rapidly with distance, and potentially meaningful EMFs would likely extend less than 50 feet (15.2 meters) from each cable. Any impacts of EMF on coastal habitats would likely be undetectable.

Light: Light from vessels transiting between berths in coastal locations to/from nearshore and offshore work locations or from vessels installing cables, if any, in the geographic analysis area for coastal habitats could occur primarily during construction, but also during operations and decommissioning. Light may also emanate from onshore structures associated with offshore wind projects (e.g., operations and maintenance facilities). Sections 3.2 and 3.3 discuss the nature of potential impacts. The extent of impacts would be limited to the immediate vicinity of the lights, and the intensity of impacts on coastal habitats would likely be undetectable.

New cable emplacement and maintenance: New offshore submarine cables could cause short-term disturbance of seafloor habitats if one or more cable routes enter(s) the geographic analysis area for coastal habitats. If cable routes intersect eelgrass or hard-bottom habitats, impacts may be long-term to permanent. Cable emplacement involves intense temporary disturbance of seafloor habitats during cable burial in an approximately 6.6-foot-wide (2-meter-wide) path along the entire cable route. Assuming future projects use installation procedures similar to those proposed in the Vineyard Wind COP (Volume I; Epsilon 2020a), coastal habitats would recover following disturbance except in hard-bottom habitat, which may be permanently altered. New cable emplacement and maintenance may affect coastal habitats multiple times, as different projects may install cable in consecutive or nonconsecutive years and maintenance may be required at any time. Any dredging necessary prior to cable installation could also contribute additional impacts, especially to eelgrass beds and hard-bottom habitats.

Noise: Noise from offshore wind construction activities, including pile driving, is not expected to be noticeable within the geographic analysis area for coastal habitats given the distance of all foreseeable projects from the geographic analysis area, but noise from trenching of export cables and from Geological and Geophysical (G&G) surveys could reach the geographic analysis area for coastal habitats. The impacts of trenching noise or noise from other methods of cable burial are temporary and typically less prominent than the impacts of the physical disturbance and sediment suspension. Noise from G&G surveys of cable routes may also enter the geographic analysis area intermittently over an assumed 4-year construction period (Table A-6 in Appendix A). 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 more similar to common deep-water echosounders. Noise is anticipated to occur intermittently over an assumed 4-year construction period in the geographic analysis area. The intensity and extent of the resulting impacts on coastal habitats are difficult to generalize, but would likely be local and temporary. Overall, noise is not anticipated to cause any meaningful change to coastal habitats.

Presence of structures: Any new cable installed in the geographic analysis area for coastal habitats would likely require hard protection atop portions of the route, potentially converting previously existing habitat (whether hard-bottom or soft-bottom) to a type of hard habitat, although it differs from the typical hard-bottom habitat in the geographic analysis area—namely, coarse substrates in a sand matrix. The new habitat may or may not function similarly to hard-bottom habitat typical in the region (HDR 2019; Kerckhof et al. 2019). Soft-bottom habitat is the dominant habitat type on the OCS, and structures do not meaningfully reduce the amount of soft-bottom habitat available (Guida et al. 2017; Greene et al. 2010). Thus, conversion of some abundant soft-bottom habitat to a rarer hard habitat may constitute a beneficial impact (NOAA 2007). Structures can also create an artificial reef effect, attracting a different community of organisms (English et al. 2017; Langhamer 2012; Paxton et al. 2020; Rosseau 2008). Cable protection is anticipated to be added incrementally over an assumed 4-year construction period in the geographic analysis area for coastal habitats (Table A-6 in Appendix A). These changes would persist as long as the structures remain. Where cables would be buried deeply enough that protection would not be used, presence of the cable would have no impact on coastal habitats.

Land disturbance: Cable landfall sites that may be sited within the geographic analysis area for coastal habitats could contribute to erosion and sedimentation during construction. The staggered nature of construction activities would limit the total erosion and sedimentation contribution at any given time, allowing coastal habitats to recover between events. Cable landfall sites and/or onshore transmission routes within the geographic analysis area for coastal habitats could cause localized degradation of onshore coastal habitats during onshore construction, although much of the shoreline is already developed, limiting the value of habitat there. Such an effect could also involve land use changes that permanently convert onshore coastal habitats to developed space.

Seabed profile alterations: If dredging is used in the course of cable installation within the geographic analysis area for coastal habitats, localized, short-term impacts on coastal habitats would result. Dredging typically occurs only in sandy or silty habitats, which are abundant in the geographic analysis area and are quick to recover from disturbance (Wilber and Clarke 2007). Furthermore, sand waves in the geographic analysis area naturally move across the seafloor throughout the year. Therefore, such impacts, while locally intense, would be short-term and would have little impact on the general character of coastal habitats.

Sediment deposition and burial: Dredged material disposal that may occur in the geographic analysis area for coastal habitats could cause temporary, localized turbidity increases and long-term sedimentation or burial at the immediate disposal site; however, dredged material disposal is usually not permitted in SSU habitats, and it would therefore likely have little effect on coastal habitats as defined in this section. Cable installation and maintenance activities in or near the geographic analysis area during construction or maintenance of future offshore wind projects could also cause sediment suspension and re-deposition. These impacts would likely be undetectable in habitats other than hard-bottom habitats, while in hard-bottom habitats, the impacts would likely be small and short-term to long-term, depending on the thickness of deposited sediment, local currents, and the nature of the habitat affected (Wilber et al. 2005). Sediment deposition from simultaneous or sequential activities would likely not be interactive.

Climate change: Climate change, influenced in part by greenhouse gas (GHG) emissions, is expected to continue to contribute to a widespread loss of shoreline habitat from rising seas and erosion. Ocean acidification caused by atmospheric carbon dioxide (CO_2) may contribute to reduced growth or the decline of reefs and other habitats formed by shells. Section A.8.1 has details on the expected contribution of offshore wind activities to climate change.

3.1.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, coastal habitats would continue to follow current regional trends and respond to current and future environmental and societal activities. Conditions of coastal habitats in the geographic analysis area for coastal habitats are relatively stable, but variable across space and time. Eelgrass habitats are in decline, with a loss of over 20 percent from 1994 to 2011 (Costello and Kenworthy 2011). Sandy beaches in the region are subject to erosion and are vulnerable to the effects of projected climate change and relative sea level rise (Roberts et al. 2015). Coastal habitats at and landward of the shoreline are partially developed, and this development is likely to continue.

While the proposed Project would not be built as proposed under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind activities, and future offshore wind activities to have continuing temporary to permanent impacts on coastal habitats primarily through anchoring, new cable emplacement and maintenance, noise, the presence of structures, land disturbance, seabed profile alterations, sediment deposition and burial, and climate change. BOEM anticipates that the impacts of ongoing activities, especially sediment dredging, dredge fishing and bottom trawling, and land disturbance, would be **moderate**. In addition to ongoing activities, BOEM anticipates that the impacts of planned actions other than offshore wind would be **minor**. BOEM expects the combination of ongoing activities and planned actions other than offshore wind to result in **moderate** impacts on coastal habitats, primarily driven by ongoing activities.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable planned actions other than offshore wind would include both **minor beneficial** and **moderate** impacts. The majority of offshore structures in the geographic analysis area for coastal habitats would be attributable to the future offshore wind industry. The future offshore wind industry would also be responsible for the majority of impacts related to new cable emplacement. Except for those two IPFs, the impacts of the future offshore wind activities would be difficult to distinguish from the impacts of ongoing activities and future non-offshore wind activities. BOEM expects that ongoing impacts resulting from sediment dredging, dredge fishing and bottom trawling, and land disturbance would continue to be the most impactful IPFs influencing the condition of coastal habitats in the geographic analysis area for coastal habitats.

3.1.2. Consequences of Alternative A

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on coastal habitats:

- OECC route near Muskeget Channel: The OECC route may travel around (Eastern Muskeget Option) or through Muskeget Channel (Western Muskeget Option). The Eastern Muskeget Option is approximately 1.8 miles (2.9 kilometers) longer and contains more mapped hard/complex bottom habitat than the Western Muskeget Option (COP Volumes I-III; Epsilon 2018a, 2019c, 2020a, 2020b).
- Dredging and cable installation methods: Among the several methods proposed (see the new cable emplacement and maintenance IPF below), the TSHD would likely cause greater impacts, both in the dredging corridor and in the spoils dumping areas, than would jetting or mass flow excavation. Likewise, Vineyard Wind might be able to accomplish cable burial with fewer impacts if jetting were the primary burial method used, especially if it can avoid the need for dredging.

Alternative A would likely result in impacts that are expected to be local and to not alter the overall character of coastal habitats in the geographic analysis area. Cable installation, including pre-lay dredging of sand waves, if used, could have noticeable temporary impacts. The creation of hard-bottom habitat atop the offshore export cable would cause a permanent (for the life of the Proposed Action), possibly beneficial, impact. Alternative A alone would likely result in **negligible** to **minor beneficial** and **negligible** to **moderate** impacts as a result of individual IPFs.

Alternative A would contribute to impacts on coastal habitats through all of the IPFs named in Section 3.1.1 except for light from structures, noise from construction, and land disturbance. The most impactful IPFs under Alternative A would likely include anchoring, new cable emplacement/maintenance, and the presence of structures. Other IPFs would likely contribute impacts of lesser intensity and extent, and would occur primarily during construction, but also during operations and decommissioning (Table 3.1-1).

Accidental releases: Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities, if they were to occur, would generally require intense, temporary activity to address emergency conditions, accidental spills of fuel, lubricating oils, HDD drilling mud, or other materials used inside equipment during construction, operations and maintenance, and decommissioning. Vineyard Wind's implementation of the draft Oil Spill Response Plan (COP Volume I; Epsilon 2020a) is anticipated to limit any effects of accidental releases from Alternative A alone to **minor** impacts.

The **minor** incremental impact of Alternative A would slightly increase the risk of accidental releases beyond that under the No Action Alternative. Table A.8.2-1 in Appendix A provides a quantitative analysis of these risks. In context of reasonably foreseeable environmental trends, the combined impacts on coastal habitats (contamination) from this IPF from ongoing and planned actions, including Alternative A, would likely be localized, temporary, and **minor** due to the likely limited extent and duration of a release. Accidental releases of trash and debris are not likely to have any detectable impact on coastal habitats within the geographic analysis area.

Anchoring: Plans call for anchoring in Muskeget Channel, although anchoring may also occur anywhere along the OECC (COP Volume II-A; Epsilon 2018a). Vineyard Wind has developed an anchoring plan to minimize impacts (Epsilon 2018c). Anchoring would not be allowed within known eelgrass beds, and vessels deploying anchors would avoid SSU habitats to the greatest extent practicable. Vineyard Wind estimated that anchoring would disturb up to 4.4 acres (17,806 square meters), some of which would occur outside the geographic analysis area for coastal habitats—that is, offshore of the 3-nautical-mile seaward limit defining coastal habitats (Epsilon 2018d). Anchors would leave a temporary mark on the seabed. If the proposed Project anchored upon any hard/complex bottom or cobble-sponge beds, damage or destruction of that part of the habitat could result in **moderate** impacts. For those areas outside of SSU habitats, the proposed Project impacts would be **minor**, as the disturbances would recover naturally. The **minor** to **moderate** incremental impact of anchoring under Alternative A alone would result in temporary to permanent impacts on coastal habitats, depending on the nature of the habitat affected.

In context of reasonably foreseeable environmental trends, combined anchoring impacts on coastal habitats from ongoing and planned actions, including Alternative A, would likely be **minor** to **moderate**, localized, and temporary, but could be permanent if they occur in eelgrass beds or boulder piles.

BOEM has considered the development and implementation of an anchoring plan (Appendix D) as an additional mitigation and monitoring measure for this resource, potentially in combination with additional habitat characterization. Such a plan could reduce the area of sensitive habitats affected by anchoring, possibly reducing the severity of anchoring impacts.

EMF: Considering the proposed cable burial depth and shielding, the extent of EMF would likely be less than 50 feet (15.2 meters) from any cable, and the intensity of impacts on coastal habitats would likely be **negligible**. Sections 3.2 and 3.3 discuss the nature of potential effects. The **negligible** incremental impact of Alternative A alone would slightly increase EMF in the geographic analysis area for coastal habitats beyond the EMF that would occur under the No Action Alternative, which would likely have undetectable impacts on coastal habitats. It is highly unlikely that any two cables would be close enough together that their effects of EMF would overlap. In context of reasonably foreseeable environmental trends, combined EMF impacts on coastal habitats from ongoing and planned actions within the geographic analysis area, including Alternative A, would likely be **negligible**.

Light: Alternative A alone would not result in new lighted structures within the geographic analysis area for coastal habitats. Alternative A would allow nighttime work only on an as -needed basis, in which case the proposed Project would reduce lighting of vessels, so light from vessels would also be minimal. Therefore, light resulting from Alternative A alone would likely lead to **negligible** impacts, if any, on coastal habitats.

The minimal amount of light from vessels under Alternative A would be in addition to the light from vessels under the No Action Alternative. Further light from existing structures and future offshore wind-related structures onshore or nearshore may reach coastal habitats near shore. In context of reasonably foreseeable environmental trends, combined light impacts on coastal habitats from ongoing and planned actions within the geographic analysis area, including Alternative A, would likely be **negligible**.

New cable emplacement and maintenance: Vineyard Wind would bury the proposed offshore export cable within the OECC to a target depth of up to 5 to 8 feet (1.5 to 2.5 meters) below the seafloor. The OECC would contain up to two cables laid within a 3,280-foot (1,000-meter) corridor, which would be the maximum width; the overall majority of the corridor width would be 2,657 feet (810 meters). Vineyard Wind has proposed several cable burial methods that would be used in different portions of the OECC or in combination. Jetting, or mass flow excavation, uses water jets to push sediment aside, but this method is not able to remove as much sediment as dredging, which may be required on larger sand waves. For cable burial, jet plowing, which is a similar method, uses water pumped into the seabed to fluidize the bed and allow the cable to sink to the appropriate depth. Mechanical plowing would bury the cable behind a cutting edge that is pushed through the seabed. Mechanical trenching, which would be mostly used for coarser sediments, uses a rotating cutting tool to create a trench in which the cable can be installed and buried. Other possible installation techniques include precision installation by divers or remotely operated vehicles (ROVs) and a blunt plow used to push aside boulders (COP Volume I, Section 4.2.3.3.2; Epsilon 2020a). As discussed in Section 2.1.1.1.2, Vineyard Wind's expected installation tool within the geographic analysis area for coastal habitats is a vertical injector jetting tool, which can penetrate sand waves and avoid the need for dredging. Although difficult to predict quantitatively, burial impacts would likely be minimized if jetting and/or plowing methods were used (BERR 2008), especially if these methods avoid the need for dredging, resulting in **minor** impacts.

The process of cable laying and burial would affect seafloor coastal habitats along the OECC (Figure 2.1-3). Although some of the OECC area is outside the 3-nautical-mile line that defines coastal habitat, cable installation along the entire OECC may temporarily affect up to 96 acres (0.39 km^2) in the maximum-case scenario, which uses the Eastern Muskeget Option. This process would affect coastal habitats through cable burial, sediment suspended by the burial process, and the installation of rock or concrete protection. Where Vineyard Wind would install the cable over coarse substrates (shell aggregates, pebble-cobble, etc.), the coarser material would likely settle first and become covered by the finer sandy and silty materials that settle more slowly. Thus, the proposed Project would likely convert some surface area to a simpler surface of lower habitat value.

Cable installation would disturb biogenic structures along the OECC leading to the Covell's Beach landfall site (COP Volume II-A; Epsilon 2018a). The approach to Covell's Beach would also pass within approximately 300 feet (90 meters) of hard-bottom habitat and within approximately 1,000 feet (305 meters) of an eelgrass bed. Cable installation would not require any disturbance to these sensitive habitats, as Vineyard Wind would avoid the hard/complex bottom habitat and eelgrass bed (COP Volume II-A; Epsilon 2018a). At the landfall site, onshore impacts on coastal habitat would be nonexistent to **negligible** because the use of HDD to transition from offshore to onshore would avoid coastal habitats of the Covell's Beach area. The OECC route in the vicinity of Muskeget Channel may affect the level of impact. While both of the proposed route options through the Muskeget Channel area contain hard-bottom habitats and complex bottom, Vineyard Wind prefers the Eastern Muskeget option because it has favorable slopes and a lower concentration of large boulders (COP Addendum to Volumes I, II, and III, Section 2.1.3; Epsilon 2019a). The areas of each coastal habitat type present along the OECC are shown for each Muskeget Channel option in Table 3.1-2. The Eastern Muskeget Option is approximately 1.8 miles (2.9 kilometers) longer and contains more hard/complex bottom habitat, as defined by CZM (2014) and the Commonwealth of Massachusetts (2015), by area than the Western Muskeget Option, while the Western Muskeget option contains more complex seafloor (i.e., sand waves) and a higher concentration of large boulders. Therefore, the effects on the hard-bottom habitat within either Muskeget option could result in **moderate** impacts, while flatter, sandier areas would likely experience **minor** impacts that may recover naturally.

Maintenance of the offshore export cables could have an impact on submerged coastal habitats if vessel anchoring, seafloor dredging, or the removal of scour protection were necessary to effect cable repairs. The effects would be similar in nature to initial cable installation, but would be smaller in physical extent.

The **minor** to **moderate** incremental impact of Alternative A alone would disturb up to an estimated 96 acres (0.39 km^2) of sea floor within the OECC during cable installation (although some of these areas would lie outside of the geographic analysis area for coastal habitats), which would be in addition to the disturbance caused by cable emplacement and maintenance under the No Action Alternative. The physical disturbance from installation of any two cables would not overlap, even within a single OECC, but see the IPF below regarding sediment deposition and burial. In context of reasonably foreseeable environmental trends, the combined impacts of new cable emplacement and maintenance on coastal habitats from ongoing and planned actions, including Alternative A, would likely be **minor** to **moderate**, local, short-term to permanent disturbances of seafloor habitats. Section 3.2 includes a more complete description of seafloor impacts from cable placement.

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredging and cable installation methods and timing, as described in Appendix D, potentially in combination with additional habitat characterization.

This could reduce the degree of new cable emplacement impacts compared to the maximum-case scenario, although the impacts described above would still occur; therefore, the significance level of these impacts would remain the same.

Noise: Noise from trenching and burial of export cables may occur during construction, although most of the export cables would be installed using a trenchless jet-plowing method. Trenching and burial noise would be temporary, local, and extend only a short distance beyond the emplacement corridor. Impacts of trenching and burial noise are typically less prominent than the impacts of the physical disturbance and sediment suspension. Noise from trenching and burial would likely have **negligible** impacts on coastal habitats. Alternative A would also emit noise from G&G surveys used to inspect the cables after installation. G&G noise resulting from cable route surveys is anticipated to cause temporary, **negligible** impacts in the immediate vicinity of the cable routes.

Alternative A would have a **negligible** incremental impact on coastal habitats through noise related to G&G activities and trenching, while no impacts on coastal habitats of noise from construction or pile driving can be attributed to the Proposed Action, although ongoing activities are expected to result in local temporary impacts. In context of reasonably foreseeable environmental trends, the combined impacts on coastal habitats of noise from ongoing and planned actions, including Alternative A, would likely be **negligible**, with the possible exception of pile-driving noise from ongoing activities that occur periodically in nearshore areas when piers, bridges, pilings, and seawalls are installed or upgraded.

Presence of structures: Vineyard Wind has conservatively assumed that up to 10 percent of the offshore export cable would require cable protection where proper cable burial depths are not achievable. However, Vineyard Wind considers cable burial a priority, and would use iterative analyses of survey data, advanced burial techniques, and micro-routing to maximize burial and minimize the need for cable protection (Epsilon 2018c). See Section 2.1.1.1.2 for more information on cable burial risk. Given that most of the seabed in and near the proposed OECC is flat sand and silt, the addition of rock or concrete protection atop sections of the buried cable would change the nature of the seabed habitat. Vineyard Wind estimates that up to 35 acres (0.1 km^2) of cable corridor within the OECC would need protection, although some of this would occur outside the geographic analysis area for coastal habitats. The types of cable protection under consideration include rock placement, concrete mattresses, or half-shell pipe ducts (COP Volume I, Section 3.1.5.3; Epsilon 2020a). According to the Supplemental Draft Environmental Impact Report (Epsilon 2018d), rock placement is likely to be used if relatively large areas of cable protection are needed, concrete mattresses are likely to be used only if limited areas of cable protection are needed, and half-shell pipes are less likely to be used. By adding hard surfaces, vertical relief, and habitat complexity, such changes could lead to increases in faunal diversity (Langhamer 2012; Taormina et al. 2018). However, benthic monitoring at the Block Island Wind Farm has found that mussels and other organisms have failed to colonize concrete mattresses. Other hard surfaces at Block Island Wind Farm have seen rapid growth by mussels and other organisms (HDR 2019). Placement of cable protection, especially in areas of natural hard-bottom habitat, may cause additional **minor** impacts in the areas affected by new cable emplacement and maintenance. The conversion of some abundant soft-bottom habitat to a rarer hard habitat, and the increase in faunal diversity that is likely to result, would be considered a **minor beneficial** impact (NOAA 2007), although the new habitat may or may not function similarly to hard-bottom habitat typical in the region (HDR 2019; Kerckhof et al. 2019). Invertebrate and fish assemblages may develop around these reef-like elements within the first year or two after construction (English et al. 2017). Although some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the reef effect results in increased productivity versus simply attracting and aggregating fish from the surrounding areas (HDR 2019). Either way, the level of aggregation or attraction associated with cable protection in coastal areas is anticipated to mainly occur at the individual level, not a population level. However, if Vineyard Wind installed protection atop existing hard/complex bottom habitat, alteration of that portion of the habitat could occur; the change in habitat quality at any one of those sites might be positive or negative (Sheehan et al. 2018). In any case, there would likely be a period of reduced ecological function during installation and for some time afterward as the processes of colonization and succession occurred on the new substrate (Sheehan et al. 2018). Considering that much of the proposed OECC is not hard/complex bottom, it is possible that Vineyard Wind's cable protection would add more hard-bottom habitat area than would be damaged by the cable protection installation. Thus, the hard protection aspect of Alternative A alone might result in a **minor beneficial** and **minor** impact on coastal habitats.

During decommissioning, Vineyard Wind may remove the offshore export cable and cable protection unless otherwise authorized by BOEM (COP Volume I Section 4.4; Epsilon 2020a). This could have a further impact on submerged coastal habitats. Any hard-bottom habitat that had been created by the Project would thus be removed, returning the habitat to its original type.

In the context of reasonably foreseeable environmental trends, BOEM anticipates that Alternative A would cause local, **minor beneficial** impacts and **minor** impacts on coastal habitats through this IPF in addition to the impacts that would occur under the No Action Alternative, which would have an unknown extent, but would likely be similar to that of Alternative A alone. Combined impacts of this IPF from ongoing and planned actions, including Alternative A, would likely be local, permanent (as long as the structures remain), **minor beneficial** impacts and **minor** impacts on coastal habitats. These impacts may benefit some communities that depend on hard habitat, although the habitats that existed previously would no longer exist at the affected locations.

BOEM could require Vineyard Wind, as a condition of COP approval, to use only certain types of cable protection, as described in Appendix D. The use of natural materials and nature-inclusive designs would increase the probability of recolonization by benthic organisms and use of the introduced substrate as habitat. Therefore, this would reduce the degree of adverse impacts from cable protection and enhance the degree of possibly beneficial impacts, although the significance level of impacts would remain the same.

Seabed profile alterations: At locations with large sand waves, dredging of the top 1 to 14 feet (0.5 to 4.5 meters) may be necessary. Vineyard Wind has indicated that a need for dredging is unlikely and the company has not reserved any dredging equipment at this time. If needed, a TSHD would remove sediment using suction, store the sediment in a hopper, and dump the sediment in piles on the sea bottom at a different place within the OECC, several hundred yards away from the dredged area. The maximum-case scenario of the immediate burial corridor through the use of dredging is proposed to affect up to approximately 69 acres (0.3 km^2) of bottom habitat, although some of this would occur outside of the geographic analysis area for coastal habitats. Considering the area affected in relation to the expanse of surrounding sand wave habitat, impacts would likely be **minor**.

Dredging under Alternative A would be in addition to the impacts that would occur under the No Action Alternative, which would have an unknown extent but would likely be similar to that of Alternative A. In context of reasonably foreseeable environmental trends, the combined impacts of this IPF on coastal habitats from ongoing and planned actions, including Alternative A, would likely be **minor**.

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredging methods, as described in Appendix D. This would reduce the area and degree of dredging-related impacts compared to the maximum-case scenario, possibly reducing the level of the impacts of Alternative A alone on coastal habitats via seabed profile alterations.

Sediment deposition and burial: Vineyard Wind conducted a sediment transport analysis to model the potential distribution of suspended sediment during dredging and cable installation (COP Volume III, Appendix III-A, Epsilon 2020b; Epsilon 2018d). In this conservative model, the entire route was assumed to consist of the sediment sample with the greatest relative fraction of fine material, which was approximately 23 to 29 percent; the model evaluated sediment suspension from dredging and from jetting used for cable burial. The sediment model indicated that sediment deposition greater than 0.04 inch (1 millimeter) would be mostly limited to within approximately 328 feet (100 meters) of the cable centerline (COP Volume III, Appendix III-A; Epsilon 2020b). Deposition of 0.04 to 0.2 inch (1 to 5 millimeters) would probably have a **minor** impact on seafloor habitat, as normal water movements would likely redistribute this thin layer of sediment, while deposition of lesser amounts would probably have a negligible impact on coastal habitats or organisms (Wilber et al. 2005). According to the model, deposition of 0.04 to 0.2 inch (1 to 5 millimeters) of sediment could potentially occur on up to 2,248 acres (9.1 km^2) (although part of this area would lie outside of the geographic analysis area for coastal habitats), while deposition of more than 0.2 inch (5 millimeters) would be limited to 91 acres (0.4 km^2) along the OECC. The impact of such sediment deposition would likely be undetectable in habitats other than hard-bottom habitats, while in hard-bottom habitats, the impacts would likely be **minor** and short-term to permanent, depending on the thickness of deposited sediment, local currents, and the nature of the habitat affected (Wilber et al. 2005).

Sedimentation of eelgrass or shellfish beds could negatively impact habitat quality, and any eelgrass beds within approximately 328 feet (100 meters) of the cable centerline would be vulnerable; however, the closest such habitat is the Spindle Rock eelgrass bed and hard-bottom habitat complex near the proposed OECC approaching the Covell's Beach landfall site (Figure 1-4 in Epsilon 2018d). Vineyard Wind intends to route the cable on the eastern side of the OECC to avoid the eelgrass and hard-bottom habitat at Spindle Rock. Using the preliminary cable alignment, the closest distance between the western cable and the eelgrass is approximately 1,000 feet (305 meters). The closest distance between the western cable and the hard-bottom habitat near Spindle Rock is approximately 300 feet (90 meters). According to the results of the sedimentation model (COP Volume III, Appendix III-A; Epsilon 2020b), cable installation should not affect the eelgrass, given its distance from the cable. Given the distance between the hard-bottom habitat near Spindle Rock and the preliminary cable routes, most sediment deposition from cable installation would not affect this habitat, although there is the potential for the closest portion of the Spindle Rock complex to fall within the outer limits of the potential area of deposition.

Sediment deposition and burial would also occur where dredged materials, if any, are deposited. In addition to the area buried by the main part of each dredge spoils pile, sedimentation is predicted to extend a considerable distance from the pile; deposition greater than 0.8 inch (20 millimeters) may extend up to 0.5 mile (0.9 kilometer) from each disposal site and cover up to 34.6 acres (0.1 km^2) (COP Volume III, Appendix III-A; Epsilon 2020b). Alternatively, jet excavation and/or jet plowing would minimize the movement of sediment outside of the immediate burial corridor, and thus would affect less area of coastal habitat along the OECC. Considering that the effects of sediment deposition and burial would remain measurable until the impacting agents were removed, the impacts of sediment deposition under Alternative A alone would likely be **minor**.

Sediment deposition under Alternative A alone would be in addition to the impacts that would occur under the No Action Alternative, which would have an unknown extent but would likely be similar to that of Alternative A alone. Sediment deposition would have no impact on coastal habitats outside of eelgrass beds and hard-bottom habitats, where the impacts would be short-term to long-term, with intensity and duration proportional to the thickness of the sediment layer deposited. Multiple projects using the same OECC or causing sediment plumes to enter the coastal habitats geographic analysis area could cause repeated sedimentation of coastal habitats. In context of reasonably foreseeable environmental trends, the combined impacts of sediment deposition and burial on coastal habitats from ongoing and planned actions, including Alternative A, would likely be **minor**.

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredge disposal sites, as described in Appendix D. This could minimize impacts on sensitive habitats and allow for the identification of potential remedial efforts if misplacement of materials were to occur. Although this could reduce the impacts of burial during dredged material disposal, the sediment deposition impacts described above would still occur; therefore, the significance level of impacts would remain the same.

Climate change: This IPF would contribute to the reduced growth or decline of some types of coastal habitats, the widespread loss of shoreline habitat from rising seas and erosion, and alterations to ecological relationships. Because this IPF is a global phenomenon, the impacts on coastal habitats through this IPF would be the same as those under the No Action Alternative. The intensity of impacts on coastal habitats resulting from climate change are uncertain, but are anticipated to qualify as **minor** to **moderate**.

Other considerations: For temporary impacts, including the effects of noise, light, and thin layers of sediment deposition, it is likely that a portion, possibly the majority, of such impacts from future activities would not overlap in time with the temporary impacts of the Proposed Action. However, some IPFs (e.g., sediment deposition) that can cause temporary impacts can also cause long-term impacts.

In summary, throughout the entire OECC, Alternative A could negatively affect up to 169.4 acres (0.69 km^2) through IPFs other than sediment deposition, could result in sediment deposition across 2,248 acres (9.1 km^2), and could affect up to 35 acres (0.1 km^2) through the presence of structure. In summary, BOEM's analysis presented above concludes the following:

- Vessel anchoring would result in **minor** to **moderate** impacts.
- Dredging, if used, and cable installation would result in **minor** to **moderate** impacts.

- The addition of hard protection might result in a **minor beneficial** impact and **minor** impacts.
- Sedimentation could affect the largest area, and would likely result in **minor** impacts.

Vineyard Wind may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above; however, doing so would not likely result in different impact ratings than those described above. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.1.1.2.

In context of reasonably foreseeable environmental trends, considering all the IPFs together, BOEM anticipates that the overall impacts from ongoing and planned actions, including Alternative A, would result in **moderate** impacts on coastal habitats in the geographic analysis area, including some **minor beneficial** impacts. The main drivers for this impact rating are ongoing activities such as climate change, shoreline stabilization/hardening for other human uses, and fishing impacts from bottom-tending gear. Alternative A would contribute to the overall impact rating primarily through the temporary disturbance due to new cable emplacement, which may temporarily increase the impact rating from **minor** to **moderate**, and through the permanent **minor beneficial** and **minor** impacts from cable protection measures. Thus, the overall impacts on coastal habitats would likely qualify as **moderate** because the measurable impacts expected would be small and/or the resource would likely recover completely when the impacting agent were gone and remedial or mitigating action were taken.

Vineyard Wind has committed to performing monitoring both during and after construction for examining the disturbance of and recovery of coastal and benthic habitats (COP Volume III, Appendix III-D; Epsilon 2020b; Epsilon 2018c) in the Proposed Action area. Although this would involve localized disturbances of the seafloor habitat, the results of this effort would provide an understanding the Proposed Action's effects, which would benefit future management of coastal resources in this area and could inform planning of other offshore developments. While the significance level of most impacts would remain the same, BOEM could further reduce impacts with the following mitigation measures conditioned as part of the COP approval (Appendix D) as discussed under the relevant IPFs above:

- Requiring an anchoring plan, potentially in combination with additional habitat characterization, to avoid anchoring in sensitive habitats to the maximum extent practicable;
- Restricting dredging and cable installation methods and timing, potentially in combination with additional habitat characterization, to reduce the degree of dredging and cable installation impacts;
- Requiring that cable protection measures within hard-bottom habitat as defined in the COP and the EFH assessment must use natural or engineered stone that does not inhibit epibenthic growth to increase the potential use of the introduced substrate as habitat; and
- Restricting dredge disposal sites to minimize impacts on sensitive habitats.

While monitoring would not reduce impacts of the Proposed Action, BOEM could evaluate impacts, refine current knowledge of coastal habitats, and inform Vineyard Wind's decommissioning procedures, as well as others planning similar future projects, to assist in selecting the least impactful method(s). BOEM may require the following monitoring measures conditioned as part of the COP approval (Appendix D):

- Pre- and post-installation bottom profiling and video monitoring along the offshore export cable route; and
- Additional review and comment on the benthic monitoring plan.

3.1.3. Consequences of Alternatives C, D1, D2, E, and F

Alternatives C, D1, D2, E, and F differ from Alternative A only within the WDA. Because the WDA lies offshore of the geographic analysis area for coastal habitats, the impacts on coastal habitat under these alternatives would be the same as those under Alternative A alone: **minor** to **moderate** impacts and **minor beneficial**. For the same reason, the overall impacts on coastal habitats in the context of reasonably foreseeable environmental trends and planned actions would be the same—**moderate**—under Alternatives C, D1, D2, E, and F. As described above, Vineyard Wind's existing commitments to mitigation measures and BOEM's potential additional mitigation measures could further reduce impacts, but would not change the impact ratings.

3.1.4. Comparison of Alternatives

For the reasons discussed in Section 3.1.3, the consequences of Alternatives A, C, D1, D2, E, and F with respect to coastal habitats are identical. See Table 2.4-1 for a comparison of alternative impacts.

3.1.5. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. The Preferred Alternative incorporates all the mitigation and monitoring measures listed in Appendix D for this resource. The mitigation measures may reduce impacts on coastal habitats, but would not necessarily change the impact ratings (Appendix D). For the reasons discussed in Section 3.1.3, the consequences of the Preferred Alternative with respect to coastal habitats are identical to those of Alternative A. Therefore, the impacts of the Preferred Alternative would likely be **moderate**, with individual factors ranging from **minor** to **moderate** impacts and **minor beneficial** impacts. The monitoring measures would not reduce the impacts of the Preferred Alternative; however, information gained via monitoring could be used to inform Vineyard Wind's decommissioning procedures, and could be used by others planning similar future projects, to assist in selecting the least impactful method(s).

3.2. BENTHIC RESOURCES

3.2.1. No Action Alternative and Affected Environment

This section discusses baseline conditions in the geographic analysis area for benthic resources other than fishes and commercially important benthic invertebrates, which are covered in Section 3.3. This analysis is limited to impacts within the geographic analysis area for benthic resources as described in Table A-1 and shown on Figure A.7-3, namely, a 10-mile (16.1-kilometer) radius around the WDA and the OECC proposed in the Vineyard Wind COP. See Section 3.1 for a discussion of nearshore coastal habitats. Table 3.2-1 describes baseline conditions and the impacts, based on the IPFs assessed, of ongoing and future activities other than offshore wind, which is discussed below.

Benthic resources include the seafloor surface, the substrate, and the 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, rock, and ledge) habitats, as well as biogenic habitats (e.g., eelgrass, mussel beds, and worm tubes) created by structure-forming species. Benthic habitat in the geographic analysis area is estimated at 941,526 acres (3,810 km^2), of which 80 percent is sand, 18 percent is gravel/cobble/boulder, and 2 percent is mud/silt, according to an internal analysis of data from The Nature Conservancy (2014). Benthic faunal resources in the geographic analysis area include polychaetes, crustaceans (particularly amphipods), mollusks (gastropods and bivalves), echinoderms (e.g., sand dollars, brittle stars, and sea cucumbers), and various other groups (e.g., sea squirts and burrowing anemones) (Guida et al. 2017). These communities perform important functions such as water filtration and nutrient cycling, and are also a valuable food source for many species. The region experiences strong 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. Benthic organisms are commonly characterized by size (e.g., megafauna, macrofauna, or meiofauna). In soft-bottom habitats, these organisms are also characterized by whether they live on (epifauna) or within (infauna) the substrate (Rutecki et al. 2014).

Detailed descriptions of regional characteristics are available in Appendix E. The geographic analysis area for benthic resources is within the greater Georges Bank area (though not part of the bank itself) of the U.S. Northeast Shelf Large Marine Ecosystem (Kaplan 2011). Table 4-7 in Guida et al. (2017) describes the seven benthic habitat types found in Georges Bank and the characteristic faunal assemblages of each habitat type. Guida et al. (2017) reported that amphipods and polychaetes numerically dominated infaunal communities in samples spanning WLAs OCS-0500, OCS-0501, OCS-0502, and OCS-0503, and sand shrimp (*Crangon septemspinosa*) and sand dollars dominated benthic epifaunal assemblages in those samples. Grab samples taken in 2011 south of Cape Cod, in the vicinity of the geographic analysis area for benthic resources, found abundant nut clams, polychaetes, and amphipods, as well as oligochaetes and nemertean ribbon worms (AECOM 2012). Large bivalves, such as clams and scallops, are also present (Powell and Mann 2016; Powell et al. 2017); these and other commercially important species are discussed in Section 3.3.

Detailed data in the geographic analysis area for benthic resources are mostly limited to the OECC and WDA. COP Sections 2.1.1.3 and 5.1 characterize the sediment types and benthic habitat in these areas (Volume II-A; Epsilon 2018a). The seafloor in the OECC and WDA is predominantly composed of unconsolidated sediments ranging from silt and fine-grained sands to gravel. Local hydrodynamic conditions largely determine sediment types, with finer materials in low-current areas and coarser materials in high-current areas. Coarse glacial till is found in the high-current portions of Nantucket Sound, especially near Muskeget Channel. Coarser materials on the seafloor include gravel, cobble, and boulders, which are typically mixed with a matrix of finer sediments, and are usually found among discontinuous patches of sand (COP Volume II-A, Section 2.1.1.3; Epsilon 2018a). Benthic faunal communities in the OECC and WDA are typical for the region and vary according to habitat type along gradients in depth, hydrodynamic conditions, and substrate composition (COP Volume II-A, Section 5.1; Epsilon 2018a).

The seafloor in the WDA is mostly flat and featureless soft-bottom habitat, interrupted by sand ripples and mega-ripples (COP Addendum, Figure 2.5-2; Epsilon 2019a) as it slopes offshore to the south-southwest. Water depths range from 114.6 to 170.6 feet (35 to 52 meters). The sediment is homogenous, unconsolidated substrate dominated by fine sand and silt-sized sediments that generally become finer in deeper water (COP Volume II-A, Section 2.1.2.1; Epsilon 2018a). Medium sand predominates in the northwest portion of the WDA, and fine sand predominates across the rest of the area. Sediment type is not strongly related to water depth; although coarse and medium sand was observed only in water depths shallower than 147.6 feet (45 meters), fine and very fine sands were also observed in water depths as shallow as 124.6 feet (38 meters). Mud (silt and clay) forms a considerable fraction of the sediment in nearly all of the WDA (COP Volume II-A, Section 2.1.2.1 and Appendix II-H; Epsilon 2018a). COP Figure 5.1-3 depicts primary substrate types within the WDA (COP Volume II-A; Epsilon 2018a); substrate types are shown in greater detail in figures included in BOEM's 2019 EFH assessment, including clarifications (BOEM 2019e). Vineyard Wind did not identify any hard-bottom habitat in the WDA. The NOAA Deep-Sea Coral Data Portal does not document any live-bottom habitat (e.g., living corals) or state-managed artificial reefs (considered unique or sensitive habitat) (NOAA 2020f), although the portal is presence-only (i.e., absence of coral in the portal is not a confirmed absence of coral; instead it may indicate that the area has not been surveyed for coral). COP Figure 6.5-1 (Volume III; Epsilon 2020b) indicates that there are no known deep-sea coral locations in the WDA, and Vineyard Wind did not identify any coral in its benthic sampling (grabs and imagery) (COP Volume II A, Appendix H; Epsilon 2018a).

The WDA is part of the Southern New England Shelf as described by Theroux and Wigley (1998), which has a higher biomass and density of benthic fauna than neighboring geographic areas such as the Gulf of Maine and Georges Bank. Video surveys of benthic epifauna from 2010 to 2013 found common sand dollars (*Echinarachnius parma*) to be one of the most abundant epifauna in the WDA, as well as hydrozoans, bryozoans, hermit crabs, euphausids, sea stars, and anemones (COP Volume III, Section 6.5.1.2; Epsilon 2020b). These fauna are all common in the region; therefore, the WDA is not a biologically unique area. The NOAA Northeast Fisheries Science Center benthic trawls spanning WLAs OCS-0500, OCS-0501, OCS-0502, and OCS-0503 from 2014 found 59 taxa, of which sand shrimp, sand dollars, pandalid shrimp, and monkey dung sponge were the most abundant species. Grab samples (which target infauna) from the same survey found polychaete worms and amphipod crustaceans dominated infaunal assemblages in the WDA (COP Volume III, Table 6.5-2 and Figure 6.5-4; Epsilon 2020b). A 2016 grab sample survey by ESS Group, Inc. targeting macroinvertebrates in the WDA found a mean density of 118,370 individuals per cubic meter, which consisted of polychaete worms, crustaceans, mollusks, echinoderms, nematode roundworms, and nemertean ribbon worms; more than 50 percent of individuals were nematode roundworms, lumbrinerid polychaetes (*Scoletoma* sp.), or paraonid polychaetes (Paraonidae) (COP Volume III, Section 6.5.1.2; Epsilon 2020b). The WDA is a subset of the greater group of WLAs addressed above, and Guida et al. (2017) further described benthic communities within these WLAs, as well as other WLAs in the northeast and mid-Atlantic region.

COP Figure 2.1-12 shows the water depths along the OECC. COP Table 2.1-5 and associated figures describe the geology and sediment characteristics (Volume II-A; Epsilon 2018a). Much of the OECC is unconsolidated sediment habitat with low complexity; approximately 67 percent of video transects found mostly flat sand/mud, sand waves, and biogenic structures, while 27 percent found pebble-cobble bottom and 24 percent found shell aggregate bottom

(COP Volume II-A, Appendix H-3; Epsilon 2018a). Maps delineating certain types of benthic habitats based on the results of a 2018 survey reported in Attachment E of Epsilon 2018d are shown on Figures E.3-1a through E3-1e of Appendix E. The OECC is largely within Nantucket Sound, which has lower-than-average invertebrate density compared to the rest of the Southern New England Shelf (Theroux and Wigley 1998). Soft-bottom grab sampling found 104 different macroinvertebrate families present, 99 percent of which came from four phyla: Arthropoda (amphipods, 30 percent), Annelida (polychaete worms, 27 percent), Mollusca (clams and snails, 25 percent), and Nematoda (round worms, 16 percent) (Normandeau 2017). Mean calculated abundance per cubic meter was 17,015 individuals. Epifauna communities varied by habitat type; a detailed habitat and species count by cable corridor is available in COP Volume II-A, Section 5.1.3.2 (Epsilon 2018a). Sand dollars and burrowing anemones dominate some soft-bottom areas, while amphipods, slipper limpets (*Crepidula fornicata*), whelks, sponges, polychaetes, and spider crabs dominate others.

Earlier surveys (2001–2005) in Nantucket Sound done for the Cape Wind Project overlap with portions of the OECC; these surveys found that communities were highly variable from sample to sample, likely due to numerous microhabitats. Presence or absence of sand waves was the largest determinant of macroinvertebrate abundance; more abundant fauna (mostly filter feeders such as mussels and bivalves) were found in the troughs between sand waves, with a lower density of mobile species (such as amphipods) on the crests (MMS 2009).

Sections of the OECC in the vicinity of Muskeget Channel contain SSU habitat that consists of "hard/complex bottom," a category that includes biogenic structures, hard bottom, and complex seafloor (i.e., sand waves). Section 3.1.1 defines these habitat types, which are based on those used by CZM (2014), the Commonwealth of Massachusetts (2015) and COP Volume II-A, Section 5.2 (Epsilon 2018a) and do not necessarily align with NMFS classifications of hard, complex, or sensitive habitats as pertaining to EFH. Section 3.3 and the EFH assessment (BOEM 2019e, 2020b) discuss habitats from the perspective of finfish, invertebrates, and EFH. Hard bottom is important habitat for attachment of sessile (immobile) organisms and increases community complexity. State-mapped hard/complex bottom is shown in COP Figure 5.2-1 and was compared with video surveys done for Vineyard Wind to identify habitat along the OECC that may classify as SSU, mapped in COP Figures 5.2-2 and 5.2-3 (Volume II-A; Epsilon 2018a). The habitats mapped by Vineyard Wind's 2018 surveys are shown on Figure E.3-1 in Appendix E of this FEIS. Also see Figure E.3-2 for a depiction of seafloor conditions according to the Coastal and Marine Ecological Classification Standard substrate component. Considerable areas of coarse deposits occur along the OECC in Muskeget Channel; the COP defines and maps hard bottom as a substrate that is greater than 50 percent coarse material (COP Volume II-A, Figure 5.2-2; Epsilon 2018a). There are patches of gravel, cobble, or boulders that did not get classified as hard bottom because less than 50 percent of the sampled grid was composed of coarse substrates. However, these patchy areas could be important habitat. The 2017 video surveys found pebble-cobble habitat with sponges in Muskeget Channel. Observed hard-bottom habitat contained primarily sponges and bryozoans (COP Volume III, Section 6.5.1.4; Epsilon 2020b). Additional video surveys conducted in summer of 2018 documented abundant sulfur sponge in Muskeget Channel, as well as less frequent observations of bryozoans, sand sponge, invasive white tunicate, barnacles, bread crumb sponge, amphipods, moon snails, tube worms, and plume worms (COP Volume II-A, Appendix H-5; Epsilon 2018a). The fourth-highest species richness (ten species) was in one of the Muskeget channel transects (composed of sand waves and pebble-cobble habitat), while the lowest species counts included four transects in the sand wave habitat of Muskeget Channel. No artificial reefs were found along the OECC.

The OECC would make landfall using HDD at Covell's Beach in Barnstable. Aerial surveys show eelgrass beds on the eastern and western ends of Covell's Beach, but not along the OECC (COP Volume II-A, Figure 5.2-1; Epsilon 2018a). More recent (summer 2018) underwater transects within the OECC found a sparse to moderate distribution of eelgrass around Spindle Rock off Covell's Beach (COP Volume II-A, Section 5.2.2 and Appendix H-5; Epsilon 2018a). Vineyard Wind does not expect to encounter eelgrass beds in other portions of the OECC.

Ongoing and future activities could possibly impact the habitat, abundance, diversity, community composition, and percent cover of benthic fauna and flora. An understanding of how benthic resources are already changing is necessary for interpreting the results of potential future monitoring. There are limited data on trends within the WDA and OECC, though larger trends within coastal New England likely apply to the entire geographic analysis area for benthic resources. Benthic resources are subject to pressure from ongoing activities and conditions, especially climate change, commercial fishing using bottom-tending gear (e.g., dredges, bottom trawls, traps/pots), and sediment dredging. Studies of the Atlantic Coast from 1990 to 2010 show endemic benthic invertebrates shifting their distribution northward in response to rising water temperatures, resulting in changes to benthic community structure (Hale et al. 2016). Temperatures are predicted to continue to rise in the region, so this trend is likely to continue, leading to changes in the distributions of some species. Historical data on Centerville Harbor, which includes the Covell's Beach landfall site, show a slow decline in eelgrass bed habitat since 1951 (MassDEP 2011). Although not considered benthic habitat, beaches may be used for spawning by benthic species such as horseshoe crab (*Limulus polyphemus*), and shoreline development could impact access to spawning areas but not impact the spawning beaches themselves (MA DMF 2016b, 2018). New England horseshoe crab stocks are in decline (ASMFC 2013). According to the Massachusetts Division of Marine Fisheries (MA DMF; 2016, 2018), nesting horseshoe crabs use Covell's Beach from late spring to early summer. Dredging for navigation, marine minerals extraction, and/or military uses, as well as commercial fishing bottom-tending gear, also disturb benthic resources on a recurring basis. Effects of these activities will continue regardless of offshore wind energy development.

3.2.1.1. Future Offshore Wind Activities (without the Proposed Action)

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

Accidental releases: Accidental releases may increase as a result of future offshore wind activities. Section A.8.2 discusses the nature of releases anticipated. 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 (hazmat) mostly consist of fuels, lubricating oils, and other petroleum compounds. Because most of these materials tend to float in seawater, they are unlikely to contact 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 from ongoing activities (e.g., an accident involving a tanker ship).

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. 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. BOEM assumes all vessels would comply with laws and regulations to minimize releases. In the event of a release, 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 transportation 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 overall impacts of accidental releases on benthic resources are likely to be localized and short-term, and to result in little change to benthic resources. As such, accidental releases from future offshore wind development would not be expected to appreciably contribute to overall impacts on benthic resources.

Anchoring: In the future offshore wind scenario, there would be increased vessel anchoring during survey activities and during the construction, installation, maintenance, and decommissioning of offshore components. In addition, anchoring/mooring of met 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. Using the assumptions in Appendix A, anchoring could affect up to 56 acres (0.2 km^2). All impacts would be localized, turbidity would be temporary, and mortality of benthic resources 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.

EMF: EMF would emanate from new operating transmission cables and existing cables connecting Nantucket and Martha's Vineyard to mainland Massachusetts. In the expanded planned action scenario, an estimated 943 miles

(1,518 kilometers) of cable would be added in the geographic analysis area, producing EMF in the immediate vicinity of each cable during operation. Submarine power cables in the geographic analysis area are assumed to be installed with appropriate shielding and burial depth to reduce potential electric and magnetic fields to low levels. Wherever a cable is not buried or is buried shallowly, closer to the aerobic sediment layer, the exposure of benthic resources to magnetic fields may be stronger. EMF of any two sources would not overlap because developers typically allow at least 330 feet (100 meters) between cables (even for multiple cables within a single OECC), EMF strength diminishes rapidly with distance, and potentially meaningful EMF would likely extend less than 50 feet (15.2 meters) from each cable. Some benthic species can detect EMF, although EMF does not appear to present a barrier to animal movement. Burrowing infauna may be exposed to stronger EMF, but little information is available regarding the potential consequences. For example, BOEM's search of the available literature revealed no documented long-term impacts from EMF on clam habitat as a result of the existing power cables connecting Nantucket Island to mainland Massachusetts. In fact, there is little to no information on the EMF sensitivity of any taxa that are not commercially important (CSA Ocean Sciences, Inc. and Exponent 2019, Hutchison et al. 2018, Thomsen et al. 2015). Impacts on benthic resources would likely be undetectable, but would be permanent as long as the cables are in operation.

New cable emplacement and maintenance: New offshore submarine cables associated with the expanded planned action scenario 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 future projects are under discussion but have not been fully determined at this time. The Vineyard Wind 2 Project cable is anticipated to be in close proximity to the proposed OECC. Cables for other future offshore wind projects that would be emplaced within the geographic analysis area are anticipated to occur over the next 10 years and beyond (Table A-6). The total area of disturbance resulting from new cable emplacement is estimated to be up to 1,269 acres (5.1 km^2). This would be a small fraction of available habitat in the geographic analysis area. For example, assuming as a worst-case scenario that the entire disturbance was in gravel/boulder habitat, it would affect around 1 percent of that available habitat; in actuality, most of the disturbance would be expected to occur in sandy habitat and would affect less than 0.2 percent of that available habitat according to an internal analysis of data from The Nature Conservancy (2014). Increased turbidity would occur during cable emplacement activities for 1 to 6 hours at a time over an assumed 7-year construction period in the geographic analysis area for benthic resources (Table A-6). Disturbed seafloor from construction of those projects may affect benthic resources; assuming future 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. If routes intersect eelgrass or hard-bottom habitats, impacts may be long-term to permanent. Some types of cable installation equipment use water withdrawals, which can entrain planktonic larvae of benthic fauna (e.g., larval polychaetes, mollusks, and crustaceans) with assumed 100 percent mortality of entrained individuals (COP Volume III, Section 6.5.2.1.3; Epsilon 2020b). 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 (up to 1,200 million gallons [4,540 million liters]), BOEM does not expect population-level impacts on any given species.

When new cable emplacement and maintenance causes resuspension of sediments, increased turbidity could have an adverse impact on filter-feeding fauna such as bivalves. Most of the geographic analysis area for benthic resources contains sand that would settle out of the water column quickly, making increased turbidity brief (Epsilon 2018d). The impact of turbidity on benthic fauna depends on both the concentration of suspended sediment and the duration of exposure (Epsilon 2018d). For example, mollusk eggs do not experience sub-lethal effects until an exposure of 200 milligrams per liter (mg/L) for 12 hours; for other life stages, 24 hours of exposure is the minimum threshold for sub-lethal effects (Wilber and Clarke 2001). Modeling done for Vineyard Wind (COP Volume III, Appendix III-A; Epsilon 2020b) predicts that suspended sediment should usually settle well before 12 hours have elapsed; therefore, 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 core samples from within the nearby Lewis Bay found sediment contaminant levels were below levels of concern (MMS 2009).

All impacts through this IPF would be localized, turbidity would be present during construction for 1 to 6 hours at a time, and mortality from contact would be recovered in the short term. Any necessary dredging prior to cable installation could also contribute additional impacts (see also the IPFs of seabed profile alterations and of sediment deposition and burial).

Noise: Noise from construction, pile driving, G&G survey activities, operations and maintenance, 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 construction of each project for approximately 2 to 3 hours per foundation or for 4 to 6 hours per day for the installation of two foundations per day. 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 (Figure A.7-3) would likely occur over an assumed 7-year construction period (Table A-6), and pile-driving may occur during spring, summer, and fall. Noise transmitted through water and/or through the seabed can cause injury and/or mortality to 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. As described in Pyć et al. (2018), pile-driving noise could be loud enough to cause mortality or potentially mortal injury to benthic organisms within a radius of approximately 367 feet (112 meters) of a pile-driving event (covering an area of approximately 9.7 acres [39,254 m^2] per foundation). Data on sound exposure thresholds for lesser injuries are not available for many benthic invertebrates. Based on estimates in the COP, the extent of behavioral impacts is likely less than 5.7 miles (9.2 kilometers) around each pile. If all 257 foundations in the reasonably foreseeable offshore wind scenario are summed, mortality is expected to cover approximately 2,493 acres (10.1 km^2); it should be noted that this area overlaps all of the estimated area of foundations and foundation scour protection. The affected areas would likely be recolonized in the short term. In the reasonably foreseeable 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; it is currently unknown whether it would cause less impact on benthic faunal resources to drive many piles sequentially or concurrently.

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 7-year construction period (Table A-6). 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 trenching/cable burial, WTG operations and maintenance, and construction activities other than pile driving are expected to occur, but would have little impact on benthic resources. Noise from trenching of inter-array and export cables would be temporary, local, 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 under new cable emplacement/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 there is no information to suggest that such noise would adversely affect benthic resources (English et al. 2017). As measured at the Block Island Wind Farm, the low-frequency noise from WTG operation barely exceeds ambient levels at 164 feet (35.4 meters) from the WTG base. Based on the results of Thomsen et al. (2015) and Kraus et al. (2016a), sound pressure levels would be expected to be at or below ambient levels at relatively short distances from WTG foundations (about 164 feet [35.4 meters]). Noise from construction activities other than pile driving may occur; however, little of that noise propagates through the water, and therefore it would not be likely to cause any detectable impact on benthic resources.

Port utilization: Increases in port utilization due to other offshore wind projects would lead to increased vessel traffic. This increase in vessel traffic would be at its peak during construction activities over a period of 7 years and would decrease during operations, but increase again during decommissioning (Table A-6). In addition, any port expansion and construction activities related to the additional offshore wind projects would also add to the total amount of disturbed benthic area, resulting in disturbance and mortality of individuals and temporary to permanent habitat alteration. At least one port in the geographic analysis area is contemplating expansion/modification; this port is in Vineyard Haven (Tisbury). Existing ports are heavily modified/impaired benthic environments, and future port projects would likely implement BMPs to minimize impacts (e.g., stormwater management, turbidity curtains; Table A-5). Therefore, the degree of impacts on benthic resources would likely be undetectable outside the immediate vicinity of the port expansion activities.

Presence of structures: The presence of structures can lead to impacts on benthic resources through entanglement and gear loss/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 met towers. Using the assumptions in Appendix A, the foreseeable offshore wind scenario would include up to 257 new foundations, 219 acres (0.9 km^2) of foundation scour protection, and 250 acres (1.1 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 met towers. BOEM anticipates that structures would be added intermittently over an assumed 7-year period (Table A-6) and that they would remain until decommissioning of each facility is complete. The potential locations of cable protection for future actions have not been fully determined at this time. Although the glacial moraine and till that broadly extends from Montauk through Block Island, Martha's Vineyard, and Nantucket exhibits areas of gravel, cobble, and boulders, large hard structure (greater than 3 feet [1 meter] high) is rare in the geographic analysis area, primarily limited to a few rock outcrops (e.g., Spindle Rock) and manmade piles near shore; therefore, structure additions by future offshore wind activities would constitute a large change to the amount of large hard structure present.

The presence of structures would increase the risk of gear loss/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.

Manmade structures, especially tall vertical structures such as foundations, alter local water flow (hydrodynamics) at a fine scale (Section 3.2.2). 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 sandy seascape. 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 be permanent as long as the structures remain.

The presence of structures would also result in new hard surfaces that could provide new habitat for hard-bottom species (Daigle 2011), including blue mussels and sea anemones, as seen at the Block Island Wind Farm (Kerckhof et al. 2019; HDR 2019). However, the new surfaces could also be colonized by invasive species (e.g., certain tunicate species) found in hard-bottom habitats on Georges Bank (Frady and Mecray 2004). 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 has been studied using simulations calibrated with field observations (Raoux et al. 2017; Pezy et al. 2018; Wang et al. 2019). These studies found increased biomass for benthic fish and invertebrates. This indicates that offshore wind farms can generate some positive impacts on local ecosystems. However, some impacts such as the loss of soft-bottom habitat may be adverse. In light of the above information, BOEM anticipates that the impacts associated with the presence of structures may be slightly adverse to beneficial. The impacts on benthic resources resulting from the presence of structures would be permanent 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, and the discharges would be staggered over time and localized. There does not appear to be evidence that the volumes and extents anticipated would have any impact on benthic resources.

Regulated fishing effort: Ongoing commercial and recreational regulations for finfish and shellfish implemented and enforced by Massachusetts, towns, and/or NOAA, depending on jurisdiction, affect benthic resources by modifying the nature, distribution and intensity of fishing-related impacts, including those that disturb the seafloor (trawling, dredge fishing). Offshore wind development could influence this, possibly indirectly influencing when, where, and to what degree fishing activities affect benthic resources (Section 3.10.1).

Seabed profile alterations: Dredging and/or mechanical trenching used in the course of cable installation can cause localized short-term impacts (habitat alteration, injury, and mortality) on benthic resources through seabed profile alterations, as well as through the sediment deposition IPF. The level of impact from seabed profile alterations could depend on the time of year that they occur, particularly in nearshore locations, especially if they overlap with times and places of high benthic organism abundance. Locations, amounts, and timing of dredging for future 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 (Table A-4), such impacts from future offshore wind activities would likely be on the order of 3 times more than the Proposed Action alone. 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 (Boyd et al. 2005). 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. Therefore, seabed profile alterations, while locally intense, have little impact on benthic resources in the geographic analysis area.

Sediment deposition and burial: Cable emplacement and maintenance activities (including dredging) in or near the geographic analysis area during construction or maintenance of future offshore wind projects could cause sediment suspension for 1 to 6 hours at a time, after which the sediment is deposited on the seafloor. Sediment deposition can result in adverse impacts on benthic resources, including smothering. Benthic organisms' tolerance to being covered by sediment (sedimentation) varies among species. The sensitivity threshold for demersal eggs (such as fish or squid eggs) is sediment deposition greater than 0.04 inch (1 millimeter) (Berry et al. 2011); the sensitivity threshold for shellfish varies by species, but can be generalized as deposition greater than 0.79 inch (20 millimeters) (Colden and Lipcius 2015; Essink 1999; and Hendrick et al. 2016, as cited in COP Volume III, Section 6.5.2.1.3; Epsilon 2020b). 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. Cable routes for future projects are under discussion but have not been fully determined at this time. The Vineyard Wind 2 Project cable is anticipated to be in close proximity to the proposed OECC. Cables for other future offshore wind projects that would be emplaced within the geographic analysis area would likely be between 2022 and 2026 (Table A-4). Locations, amounts, and timing of dredging for future offshore wind projects are not known at this time. Assuming the areal extent of such impacts is proportional to the length of cable installed (Table A-4), such impacts from future offshore wind activities would likely be on the order of 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 impacted areas would only be lightly sedimented (less than 0.04 inch [1 millimeter]) and would recover naturally in the short term. If any occurs in the geographic analysis area, dredged material disposal during construction 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 likely be short-term to long-term.

Climate change: Benthic resources may be affected by climate change, including ocean acidification and warming, sea level rise, and altered habitat/ecology. Ocean acidification caused by atmospheric CO_2 may contribute to reduced growth or the decline of benthic resources with calcareous shells (PMEL 2020). Warming of ocean waters is expected to influence the distribution and migration of benthic resources, and may influence the frequencies of various diseases (Hoegh-Guldberg and Bruno 2010; Brothers et al. 2016). Because this IPF is a global phenomenon, impacts on benthic resources through this IPF would be practically the same in the expanded planned action scenario as they would be with only ongoing activities. See Section A.8.1 for details on the expected contribution of offshore wind development to climate change.

Other considerations: During operations, powered transmission cables would produce heat (Taormina et al. 2018). Studies of heat from buried cables have estimated that temperatures directly above a cable could rise by 0.19 degree Celsius (°C; 0.342 degree Fahrenheit [°F]) in sediment and by 0.000006 °C (0.0000108 °F) in the water, which are insignificant (RICRMC 2010) and not anticipated to affect benthic fauna to a measureable degree (Taormina et al. 2018).

3.2.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, benthic resources would continue to follow current regional trends and respond to current and future environmental and societal activities.

While the proposed Project would not be built under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind activities, and future offshore wind activities to have continuing temporary to permanent impacts (disturbance, injury, mortality, habitat degradation, habitat conversion) on benthic resources, primarily through pile-driving noise, anchoring, new cable emplacement, the presence of structures during operations of future offshore facilities (i.e., cable protection and foundation scour protection), climate change, and ongoing seafloor disturbances caused by sediment dredging and fishing using bottom-tending gear. Throughout the geographic analysis area for benthic resources, BOEM anticipates that the impacts of ongoing activities, especially seafloor disturbances caused by sediment dredging and fishing using bottom-tending gear, would be **moderate**. Reasonably foreseeable activities other than offshore wind include increasing vessel traffic, increasing construction, marine surveys, marine minerals extraction, port expansion, channel deepening activities, and the installation of new towers, buoys, and piers (Table 3.2-1), would result in **minor** impacts. BOEM expects the combination of ongoing activities and reasonably foreseeable activities other than offshore wind to result in **moderate** impacts on benthic resources, primarily driven by ongoing dredging and fishing activities.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in **moderate** adverse impacts and could potentially include **moderate beneficial** impacts. Future 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.

The majority of offshore structures in the geographic analysis area would be attributable to the offshore wind industry. The offshore wind industry would also be responsible for the majority of impacts related to new cable emplacement and to pile-driving noise. The total estimated area potentially subject to mortality of benthic resources from future offshore wind activities would include 2,493 acres (10.1 km^2) affected by pile-driving noise (which completely overlaps the area occupied by foundations and foundation scour protection), 250 acres (1.1 km^2) affected by hard protection atop cables, 56 acres (0.2 km^2) affected by anchoring, and 1,269 acres (5.1 km^2) affected by new cable emplacement, for a total of approximately 4,068 acres (16.5 km^2), most or all of which is expected to be recolonized. Benthic communities forming after disturbance may contain different species than before disturbance, although the community may still be of the same general type (HDR 2017, 2019; Hemery 2020; Lefaible et al. 2019). In either disturbed or converted habitats, ecological succession typically leads to changes in the community over time; in particular, new hard habitat related to offshore wind structures has been observed to initially exhibit high diversity, but to transition to low-diversity communities dominated by blue mussels and anemones after a few years (Kerckhof et al. 2019). Hard structures may benefit benthic communities that depend on hard-bottom habitat, particularly benthic epifauna, and would remove habitat for common communities that use abundant soft-bottom habitat, including infauna (Section 3.3.2). BOEM expects that ongoing seafloor disturbances caused by sediment dredging and fishing using bottom-tending gear would continue to cause considerable impacts on benthic resources in the geographic analysis area regardless of the offshore wind industry. However, if fishing using bottom-tending gear were to occur less within WTG arrays than under existing conditions, benthic resources may benefit from this reduction in bottom disturbance, although the fishing effort may simply be transferred to different locations within or outside this geographic analysis area.

The No Action Alternative would forgo the benthic resource monitoring that Vineyard Wind has committed to voluntarily perform (COP, Volume III, Appendix III-D; Epsilon 2020b and Epsilon 2020c). The results of this monitoring could provide an understanding of the impact of offshore wind development, benefit future management of benthic resources, and inform planning of other offshore developments; however, other ongoing and future surveys could still provide similar data to support similar goals.

3.2.2. Consequences of Alternative A

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on benthic resources:

- The total amount of long-term habitat alteration from scour protection for the foundations, inter-array cables, and OECC.
- The total amount of habitat temporarily altered by installation method of the export cable in the OECC and for inter-array and inter-link cables in the WDA.
- The number and type of foundations used for the WTGs and ESPs. Vineyard Wind could construct a maximum of 100 WTGs and two ESPs using either monopile (10.3 meter) or four jacket piles (9.8-foot [3-meter] pins).
- The methods used for cable laying, as well as the types of vessels used and the amount of anchoring.
- The amount of pre-cable-laying dredging, if any, and its location.
- The time of year when foundation and cable installations occur. The greatest impact would occur if installation activities coincided with sensitive life stages for benthic organisms.

Alternative A alone would likely result in impacts (disturbance, injury, mortality, habitat degradation, habitat conversion) that are expected to be local and that would not alter the overall character of benthic resources in the geographic analysis area. Impacts on benthic resources would include both temporary disturbance and permanent alteration of benthic habitat. Installation of the WTG and ESP foundations and burial of the inter-array and inter-link cables within the WDA would likely result in localized mortality of non-mobile benthic fauna, either through crushing or through smothering by displaced sediment. Installation may also disturb fish or invertebrate eggs deposited on the seafloor (i.e., demersal eggs). The degree of potential impact would vary seasonally depending on the life histories of benthic organisms. The WTGs, foundations, and associated scour protection would introduce more hard-bottom habitat to the area, which would likely be reversed during decommissioning. In areas where Vineyard Wind could not bury the cable to the target depth, rock or concrete cable protection would also alter habitat (COP Volume I, Section 3.1.5.3; Epsilon 2020a). The presence of hard structures atop the offshore export cables and at foundations would provide a type of hard-bottom habitat and would lead to a permanent (for the life of the Proposed Action), possibly beneficial, impact on some benthic assemblages (increased abundance of benthic resources that are dependent on hard surfaces) and would certainly alter the existing habitats. Heat and EMF from transmission cables could affect some benthic organisms (Taormina et al. 2018; Normandeau et al. 2011). Vessel anchoring and dredging, if used, for cable installation could have noticeable temporary impacts. Use of anchoring vessels and jack-up barges during installation, maintenance, and decommissioning, as well as benthic sampling, would all result in habitat disturbance and impacts on benthic organisms. The potential impacts would partially depend on which offshore export cable route was chosen, so this analysis assumes the maximum-case scenario. Onshore construction or increased nearshore boat traffic may impact intertidal benthic communities through noise disturbance, anchoring activities, or discharge/wastewater release. The primary mechanism through which onshore operations may affect benthic resources would be through negatively impacting water quality in nearshore waters. Section 3.1.2 discusses impacts on water quality. BOEM expects onshore operations and maintenance to have a **negligible** effect on benthic resources. Overall, the impacts of Alternative A alone on benthic resources would likely be **moderate**, and the presence of structure may result in **moderate beneficial** impacts in some locations.

Alternative A would contribute to impacts through all the IPFs named in Section 3.2.1.1 except for port utilization; Alternative A would not involve any port upgrades or changes in port utilization that would affect benthic resources, and the proposed use of an already upgraded and operating port facility is not expected to cause impacts on benthic resources. The most impactful IPFs from Alternative A alone would likely include the presence of structures, pile-driving noise, and new cable emplacement and maintenance. Other IPFs would likely contribute impacts of lesser intensity and extent (Table 3.2-1).

Accidental releases: As discussed in Section 3.2.1.1, non-routine events such as oil or chemical spills 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. Small spills should therefore have a **negligible** impact on benthic fauna. Larger spills are unlikely, but could have a larger impact on benthic fauna due to adverse effects on water quality (Section A.8.2). Accidental releases of trash and debris are discussed in Section 3.2.1.1. Alternative A would likely have no impact on benthic resources through the accidental release of trash and debris. In addition, 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 Alternative A, especially traffic from foreign ports, primarily during construction. The potential impacts on benthic resources are described in Section 3.2.1.1. The increase in the risk of accidental releases of invasive species attributable to Alternative A would be small in comparison to the risk from ongoing activities.

The **negligible** incremental impact of Alternative A would constitute a very small increase in the risk of accidental releases beyond the risk under the No Action Alternative. See Section A.8.2 for a quantitative analysis of these risks. In context of reasonably foreseeable environmental trends, the combined risk of impacts on benthic resources due to accidental releases of invasive species from ongoing and planned actions, including Alternative A, could be **major** (although most of this risk comes from ongoing activities), and the impacts (mortality, decreased fitness, disease) due to other types of accidental releases are expected to be localized, temporary, and **negligible**.

Anchoring: Vessel anchoring would cause temporary to permanent impacts in the immediate area where anchors and chains meet the seafloor. Impacts on benthic resources are greatest for sensitive benthic habitats (e.g., eelgrass beds, hard-bottom habitats). The **minor** to **moderate** incremental impact of anchoring under Alternative A would disturb up to 4.4 acres (17,806 m^2) (Table 3.2-2) in addition to the anchoring disturbance that would occur under the No Action Alternative, resulting in temporary to short-term impacts on benthic resources including turbidity, injury, mortality, and habitat degradation. The proposed Project would not anchor in eelgrass.

In context of reasonably foreseeable environmental trends, combined anchoring impacts from ongoing and planned actions, including Alternative A, could collectively affect up to 60 acres (0.2 km^2) (although some of this may occur after the resource has recovered from the earlier impacts), resulting in **minor** to **moderate** impacts on benthic resources. All impacts would be localized, turbidity would be temporary, and mortality from physical contact would be recovered in the short term. Degradation of sensitive habitats such as hard-bottom habitats, if it occurs, could be long-term to permanent.

BOEM could require Vineyard Wind, as a condition of COP approval, to develop and implement an anchoring plan (Appendix D), 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; therefore, the significance level of anchoring impacts would remain the same.

EMF: During operation, powered transmission cables would produce EMF (Taormina et al. 2018). To minimize EMF generated by cables, all cabling under Alternative A would be contained in grounded metallic shielding to prevent detectable direct electric fields. Vineyard Wind would also bury cables to a target burial depth of up to 5 to 8 feet (1.5 to 2.5 meters) below the surface, well below the aerobic sediment layer where most benthic infauna live. The scientific literature provides some evidence of faunal responses to EMF by marine invertebrates, including crustaceans and mollusks (Taormina et al. 2018; Normandeau et al. 2011). Studies on the effects of EMF to marine animals have mostly been restricted to commercially important species (Section 3.3). The consequences of manmade EMF have not been well studied in invertebrates (see Exponent 2018 and references therein). Although acknowledging that little is known about potential impacts of EMF on benthic resources, the available information suggests that field strengths expected from the proposed Project would be below levels shown to cause effects (Exponent 2018). Furthermore, there have been no documented long-term impacts from EMF on clam habitat as a result of the power cables connecting Nantucket Island to mainland Massachusetts (Northeast Regional Ocean Council 2009). Therefore, BOEM expects the impacts on benthic resources of EMF from Alternative A to be **negligible**.

The **negligible** incremental impact of Alternative A would slightly increase the impacts of EMF in the geographic analysis area beyond those under the No Action Alternative, which would likely have undetectable impacts on benthic resources. In context of reasonably foreseeable environmental trends, the combined EMF impacts on benthic resources from ongoing and planned actions, including Alternative A, would likely be **negligible**. Wherever a cable is not buried, the exposure of benthic resources to EMF may be stronger. As described in Section 3.2.1.1, EMF from multiple cables would not overlap even for multiple cables within a single OECC. Furthermore, most benthic resources are primarily not mobile or move very slowly, and thus are not susceptible to multiple exposures to EMF. 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. EMF does not appear to constitute a barrier to migration (Section 3.3).

New cable emplacement and maintenance: Cable emplacement activities would result in mortality, injury, or displacement of benthic fauna in the path of construction. The maximum area affected in the OECC is expected under the Eastern Muskeget Option (Table 3.1-2). The seafloor would be disturbed by cable trenches, skid tracks, dredging (if used), anchoring, and cable protection (Tables 3.2-2 and 3.2-3).

BOEM expects Alternative A alone to lead to unavoidable, **moderate** impacts on benthic resources from this IPF. Despite unavoidable mortality, damage, or displacement of invertebrate organisms, the area affected by the construction footprint in the WDA (394 acres [1.6 km^2]) would be just 0.5 percent of the WDA (75,614 acres [306 km^2]). 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 analysis area) as a result of Alternative A. Benthic fauna would recolonize disturbed areas that have not been displaced by new structures.

Offshore construction could also cause adverse impacts on benthic communities from loss or conversion of habitat. Based on the activities described in the COP, Vineyard Wind would avoid all eelgrass, and there is no unavoidable SSU at the landfall site (COP Volume III, Section 6.4.1, Epsilon 2020b; Sections 1.3.1.2 and 1.4.1.3 in Epsilon 2018c). Complex bottom in the form of sand waves is present through much of the OECC; however, disturbance of sand waves would be temporary, given that sand waves are changing, mobile features. Cable installation would use micro-routing to avoid hard-bottom habitat to the greatest extent practicable, although hard bottom and complex bottom extend the full width of possible routes within the OECC between Martha's Vineyard and Nantucket Island and cannot be entirely avoided (COP Volume II-A, Section 5.2.1; Epsilon 2018a). Contractors and engineers for Vineyard Wind would perform additional surveys and evaluation of geological conditions in the surface and shallow subsurface layers and develop the precise route by minimizing the following, in order of priority: length of hard-bottom habitat crossed, number of boulders encountered, volume of dredging required, and other factors; details are in the COP Addendum Section 1.2.3 (Epsilon 2019a). This process would minimize impact to hard-bottom habitat and complex bottom and maximize the likelihood of sufficient cable burial. The maximum total area of hard/complex bottom and rugged seafloor that exists within the installation corridor in Muskeget Channel ranges from approximately 1,520 acres (6.2 km^2) if using the Eastern Muskeget Option to 1,544 acres (6.3 km^2) if selecting the Western Muskeget Option (Table 1-3 in Epsilon 2018c). Installation would only affect a small subset of this area, no greater than the expected areas of impact described in Tables 3.2-2 and 3.2-3 in Appendix B (the maximum area of cable armoring is for the entire OECC; therefore, the amount Vineyard Wind would use in Muskeget Channel would be smaller). COP Figure 5.2-2 depicts the location of hard-bottom habitat within the two options through Muskeget Channel, demonstrating that portions of the corridor have hard-bottom habitat that extends the width of the corridor (where crossing hard-bottom habitat would be required) (COP Volume II-A; Epsilon 2018a). The final cable alignment would determine the exact area impacted. See COP Volume II-A, Appendix H-5 (Epsilon 2018a) for more information on Muskeget Channel.

Vineyard Wind would primarily use jet plowing and a vertical injector jetting tool for cable burial (but see Section 1.4.1.1 in Epsilon 2018c). Although difficult to predict quantitatively, burial impacts would likely be minimized if jetting and/or plowing methods were used (BERR 2008), especially if these methods avoid the need for dredging. Both methods use water withdrawals that can entrain benthic larvae (MMS 2009). An estimated 450 to 1,200 million gallons (1,703 to 4,542 million liters) of water would be withdrawn during cable installation (COP Volume III, Section 6.5.2.1.3; Epsilon 2020b). Vineyard Wind has committed to avoiding spring and summer cable burial activities in Nantucket Sound, thus avoiding the spawning season of a number of benthic invertebrates and fish that lay demersal eggs, including commercially important species described in Section 3.3. **Moderate** impacts could result from the unavoidable entrainment of benthic organisms or their planktonic larvae during cable installation using the hydraulic tools. 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 3.2.1.1.

Benthic recovery processes are relevant to understanding the likely duration of impacts on benthos. Neighboring benthic communities that have similar habitats and assemblages would recolonize disturbed areas. 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. 2003a). 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 ones. 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 benthos would likely require several months to a year or more (Dernie et al. 2003b; Lewis et al. 2002, 2003). 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 such as Nantucket Sound 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. Assemblages in sandy areas recover more rapidly (sometimes within 100 days of the disturbance) than muddy-sand areas (Elliott et al. 2017). 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).

For the OECC and WDA, Vineyard Wind is consulting with state agencies and is conducting sediment sampling and analysis, which would be required to obtain the necessary Water Quality Certification from the Massachusetts Department of Environmental Protection (MassDEP); if sediment sampling reveals contaminants, MassDEP would impose avoidance, minimization, and mitigation measures. In light of this, BOEM expects **negligible** impacts from disturbing contaminated sediments.

At Covell's Beach, Vineyard Wind would use HDD to make the landfall transition, which would affect approximately 100 square feet (9.3 m^2) of flat sand and mud. This temporary receiving pit would be back filled with the same material once the submarine cable has been brought to land. The proposed Project's shore-landfall window for the export cable would be from early April to mid-October (see Section 5.3.1 in Epsilon 2018c), and onshore construction would be restricted from June through September (unless authorized by Barnstable). Therefore, the potential exists during May for the landfall transition to overlap with the spawning season for horseshoe crabs. Horseshoe crabs use Covell's Beach as a spawning site (Section 3.3); however, HDD would not affect the beach itself and would therefore not likely affect horseshoe crab spawning. Therefore, BOEM anticipates **negligible** impacts on benthic resources from the landfall transition at Covell's Beach. Section 2.3 describes the non-routine activities associated with the proposed Project. These activities, if they were to occur, would generally require intense, temporary activity to address emergency conditions. Non-routine activities that could impact benthic resources include intensive corrective maintenance that would require exposing the cable or foundations for maintenance, or require extensive anchoring. This 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 impacted area should be substantially smaller. If corrective maintenance (i.e., cable repairs) were necessary for the landfall transition to Covell's Beach, this could affect spawning horseshoe crabs. Due to the brief duration and limited area of maintenance activities, BOEM expects **minor** impacts.

The **moderate** impact (disturbance, injury, and mortality) of new cable emplacement and maintenance under Alternative A alone, estimated to affect up to 328 acres (1.3 km^2) of seafloor within the OECC and 394 acres (1.6 km^2) in the WDA, would be in addition to the impacts caused by cable emplacement and maintenance 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 A, the total seafloor disturbance from new cable emplacement under Alternative A and other offshore wind projects is estimated to be 1,590 acres (6.4 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. Other cable installation techniques would be expected to result in similar impacts. In context of reasonably foreseeable environmental trends, the combined impacts (disturbance, injury, and mortality) of this IPF on benthic resources from ongoing and planned actions, including Alternative A, would likely be **moderate**. Any dredging necessary prior to cable installation for other offshore wind projects could also contribute additional impacts (see also the IPFs of seabed profile alterations and of sediment deposition and burial).

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredging and cable installation methods and timing (Appendix D), potentially in combination with additional habitat characterization. This could reduce the degree of new cable emplacement impacts compared to the maximum-case scenario, although the impacts described above would still occur; therefore, the significance level of impacts would remain the same.

Applicable to both construction and operational impacts, Vineyard Wind has committed to a benthic monitoring plan (Epsilon 2020c). Monitoring would survey multiple sites from each of the six different bottom habitat types present in the WDA and/or OECC both before and after construction. All sites would be sampled after construction during Years 1, 3, and if necessary, 5, and would include benthic grab sampling, high-resolution multibeam depth sounding, and underwater video.

Noise: Alternative A would result in noise from G&G surveys, WTG operations and maintenance, pile driving, and cable burial or trenching. The natures of these sub-IPFs and of their impacts on benthic resources are described in Section 3.2.1.1. Alternative A would produce noise from pile driving during installation of up to 102 foundations for approximately 2 to 3 hours per foundation or for 4 to 6 hours per day for the installation of two foundations per day. This noise would occur intermittently for up to 102 days between May and December. Technical details related to pile-driving noise are analyzed for demersal and benthic fishes and commercially important invertebrates in Section 3.3. As described in that section and in Pyć et al. (2018), pile-driving noise could be loud enough to cause mortality or potentially mortal injury to benthic organisms within a radius of approximately 367 feet (112 meters) of a pile-driving event. Data on sound exposure thresholds for lesser injuries are not available for many benthic invertebrates. Under the maximum case of installing 102 foundations, this could result in a total area of approximately 989.4 acres (4 km^2) in which benthic resources would be exposed to potential mortality from pile-driving noise. However, an area of 0.52 acre (2,104 m^2) around each foundation (53 acres [0.21 km^2] total) would be covered with scour protection that would have caused mortality regardless of the pile-driving noise; in other words, these impacts are not additive. Given that most benthic species in the region are either mobile as adults or planktonic as larvae, disturbed areas would likely be recolonized naturally. Discussion of behavioral effects of pile driving on fish and commercially important invertebrates is in Section 3.3. The estimated extent of behavioral impacts is likely less than 5.7 miles (8 kilometers) around each pile. The affected areas would likely be recolonized in the short term, and the overall impact on benthic resources would be **moderate**.

The **negligible** (for most noises) to **moderate** (for pile-driving noise) impacts (disturbance, injury, and mortality) of Alternative A on benthic resources would be in addition to the noise that would occur under the No Action Alternative, which is expected to result in similar local temporary impacts. The most impactful noise is expected to come from pile driving. Considering all planned actions, including Alternative A, the area affected by pile-driving noise is expected to include potential injury or mortality across approximately 3,482 acres (14.1 km^2) and changes to individual behavior over a greater area. In context of reasonably foreseeable environmental trends, the combined impacts on benthic resources of pile-driving noise on benthic resources from ongoing and planned actions, including Alternative A, would likely qualify as **moderate**. If multiple piles are driven simultaneously, the areas of potential injury or mortality would not overlap. The areas of behavioral impacts may overlap; although the noises from driving multiple piles are unlikely to overlap at any one time, individuals may be affected by noise from sequential events before they have fully recovered from previous exposures.

BOEM could further reduce impacts and help alleviate potential mortality and injury, as a condition of COP approval, with the mitigation measures of pile-driving noise reduction and pile-driving sound source verification (Appendix D).

The use of noise-reduction technologies during all pile-driving activities to ensure a minimum attenuation of 6 decibels (dB) would reduce the area impacted by noise during construction. This would ensure that the maximum distance of potential mortal injury during pile driving would not exceed the estimates discussed above. The specific technologies have not yet been selected; potential options include a Noise Mitigation System, Hydro-sound Damper, Noise Abatement System, a bubble curtain, or similar (Pyć et al. 2018). In addition to the use of one sound attenuation system, Vineyard Wind has committed to complete sound field verification and to have a second attenuation technology on hand, which would be deployed if sound field verification demonstrates a need for greater attenuation. Although these measures would minimize noise impacts, the impacts described above would still occur, and thus the significance level of impacts would remain the same.

Port utilization: Because the Proposed Action would cause no change in port utilization, no overall impacts of this IPF on benthic resources can be attributed to the Proposed Action, although ongoing and future activities, including other offshore wind projects, are expected to cause impacts.

Presence of structures: Under Alternative A, the presence of structures could result in various consequences. The natures of these sub-IPFs and of their impacts on benthic resources are described in Section 3.2.1.1. The Proposed Action could result in up to 102 foundations and 151 acres (0.6 km^2) of scour/cable protection that could cause temporary to permanent impacts of the types discussed in Section 3.2.1.1 (Table 3.2-3).

Once Vineyard Wind has completed construction, the presence of the WTG and ESP foundations would result in some alteration of local water currents, which could produce sediment scouring and alter benthic habitat. COP Appendix III-K details modeling of anticipated scour in the WDA (Volume III; Epsilon 2020b). COP Appendix III-K concludes that scour would be unlikely to occur at the proposed Project with scour protection; however, it acknowledges that no study is available regarding the potential for scour at the edges of rock scour protection. These effects, if present, would exist for the duration of the Proposed Action and would be reversed only after the Project has been decommissioned. Local changes in scour and sediment transport close to a foundation may slightly alter sediment grain sizes and benthic community structure (Lefaible et al. 2019). Any effects caused by scour would be mitigated by the addition of scour protection (COP Volume I, Section 4.2.3.2; Epsilon 2020a), which would not only protect the foundations, but also minimize effects on local sediment transport. Vineyard Wind would conduct pre-construction and post-construction surveys, and would conduct inspections during the life of the Proposed Action to ensure adequate scour protection around the foundations. Even without scour protection, minimal scour is predicted in the WDA due to fine sediments and low velocity currents, which modeling estimates at under 0.7 foot (0.2 meter) per second (COP Volume II-A, Section 3.2.2; Epsilon 2018a). With scour protection in place, the impact of scouring on benthic resources should be **negligible**.

An alteration of local water currents caused by the presence of WTG and ESP foundations could affect the dispersal of planktonic larval stages of benthic organisms. A modeling study by Chen et al. (2016) found that WTGs in the region would not have a significant influence on southward larval transport, although foundation placement could either increase or decrease larval dispersion and speed, depending on initial location; however, the models never found the foundations to trap or block larvae from settling in habitat previously occupied. The same study found that on the scale of a single turbine in a current-only regime, mean flows return to within 5 percent of background levels by approximately 8.3 times the pile diameter away from the pile. In a combined current and wave regime, flow returned to background levels within 3.5 times the pile diameter. Miles et al. (2017) suggest a rule of thumb that downstream effects have a length scale of 8 to 10 times the pile diameter, or in the case of a 33.8-foot (10.3-meter) diameter pile, within 262 to 334 feet (80 to 103 meters) from the pile. Therefore, BOEM expects any such impacts to be **negligible**.

BOEM expects impacts in the WDA from the presence of scour protection at the foundations. Scour protection would consist of a layer of rocks placed around each foundation (COP Volume I, Section 1.5.2; Epsilon 2020a). The footprint of bottom disturbance, scour protection, and cable protection in the WDA and OECC are shown in Tables 3.2.-2 and 3.2-3 in Appendix B. Cable protection and scour protection on the WTG and ESP foundations would result in long-term conversion of benthic habitat because these structures would be in place for the duration of the proposed Project. Invertebrate organisms that colonize hard substrate would likely benefit from the "reef effect" of introducing hard substrate (e.g., foundations) to seafloor areas that are largely composed of unconsolidated sediments. The types of cable protection under consideration include rock placement, concrete mattresses, and half-shell pipe ducts. Vineyard Wind has selected rock placement, or "rock dumps," as the primary protection for larger areas needing protection. This type of armoring can cause beneficial impacts by serving as hard-bottom habitat, and in particular can act as attachment sites for sessile benthic fauna (Epsilon 2018c; Section 4.3.1.4 in Epsilon 2018d). In this way, an increase in the amount of rare hard-bottom habitat can have a measurable effect on populations of organisms that require hard-bottom habitat while having no measurable effect on populations of organisms that use more abundant soft-bottom habitats.

By adding hard surfaces, vertical relief, and habitat complexity, such changes could lead to increases in faunal diversity (Langhamer 2012; Taormina et al. 2018). Invertebrate and fish assemblages may develop around these reef-like elements within the first year or two after construction (English et al. 2017). However, benthic monitoring at Block Island Wind Farm has found that mussels and other organisms have failed to colonize concrete mattresses. Other hard surfaces at Block Island Wind Farm have seen rapid growth by mussels and other organisms (HDR 2019). Some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations (English et al. 2017). This conversion to rare hard-bottom habitat, and the increase in faunal diversity that is likely to result, would be considered a **moderate beneficial** impact. However, the use of concrete mattresses would result in the loss of the existing habitat for the duration of the mattress use. Vineyard Wind has conservatively estimated that a maximum of 10 percent of total cables routes would require protection. The OECC could require up to 35 acres (0.141 km^2) of cable protection; the inter-array and inter-link cables could require a maximum of 17.7 miles (28.5 kilometers) of protection, resulting in 63 acres (0.25 km^2) of protection in the WDA. Cable protection would primarily be needed where the cable cannot be laid deep enough, which is likely to be in hard-bottom habitat (COP Volume III, Section 5.3.2.1.4; Epsilon 2020b); the addition of rock dumps would alter these areas, resulting in **moderate** permanent impacts, but ultimately would still provide a form of hard-bottom habitat, although it may or may not function similarly to hard-bottom habitat typical in the region (HDR 2019; Kerckhof et al. 2019). However, Vineyard Wind considers cable burial a priority, and would use iterative analyses of survey data, advanced burial techniques, and micro-routing to maximize burial and minimize the need for cable protection (Epsilon 2018c).

Vineyard Wind's cable burial risk assessment report indicates that the cable between the ESP (KP 62.6) and KP 42.6 would mostly not need cable protection, except between KP 51.8 and KP 48.7 where up to 1,214 feet (370 meters) of cable protection may be necessary (Appendix A; Epsilon 2019a). After KP 48.7 (just south of Muskeget Channel continuing toward shore), the sediment becomes much more variable and so does the risk for needing cable protection. Most of the WDA is soft-bottom habitat, so WTG and ESP foundation scour and cable protection (117 acres [0.5 km^2]) would result in a conversion of up to 0.15 percent of the WDA from the existing habitat to a type of hard-bottom habitat. New hard-bottom habitat might provide a favorable substrate for exotic invasive species (Langhamer 2012), potentially leading to additional impacts. The conversion of soft-bottom habitat to new hard-bottom habitat would be unavoidable, but this effect would be localized and should not have a population-level adverse impact on soft-bottom communities, while hard-bottom communities could increase from the additional hard substrate. Although some localized predation on benthic invertebrates by fish species attracted to the structure provided by foundations may result from Alternative A, these impacts are not expected to result in measurable effects on benthic resources.

Vineyard Wind would complete decommissioning within 2 years of lease termination, and it would be the reverse of the installation process, restoring the seafloor to its original state. Decommissioning of WTGs and ESPs would involve dismantling and removing them, and cutting the monopile and/or jacket foundations below the seabed, in accordance with BOEM's removal standards (30 C.F.R. § 250.913) (COP Volume I, Section 4.4.3; Epsilon 2020a). During decommissioning, offshore cables may be retired in place or removed. Removing the cables would have a similar impact as the installation process, both in the temporary disturbance to habitat and the mortality to benthic fauna that have recolonized the area. In consideration of mobile gear fisheries (i.e., dredge and bottom trawl gear), Vineyard Wind is committed to removing scour protection during decommissioning. Removal of rock and concrete mattresses could be viewed as detrimental since it would involve removing any hard-bottom communities that would have been established over the previous 30 years. However, removal of cables would return the benthic environment to its previous soft-bottom community despite the temporary impacts due to the removal process. Information gained on benthic recovery from post-construction monitoring by Vineyard Wind may potentially be used to inform decommissioning procedures and assist Vineyard Wind in selecting the least impactful method(s). A literature review by Latham et al. (2017) found that full recovery of benthic habitats following decommissioning of offshore wind facilities usually takes between 3 months and 2.5 years.

The **negligible** to **minor** impacts (disturbance, injury, mortality, increased predation, habitat degradation, and conversion) and **moderate beneficial** impacts (provision of hard-structure habitat) of Alternative A alone would be in addition to the impacts of the No Action Alternative. Using the assumptions in Appendix A, there could be up to 359 foundations, 272 acres (1.1 km^2) of scour protection, and 340 acres (1.4 km^2) of cable protection added in the geographic analysis area for benthic resources. Of this, 102 foundations, 53 acres (0.2 km^2) of scour protection and 98 acres (0.4 km^2) of cable protection would result from Alternative A alone, and the remainder is the estimated result of other offshore wind projects in the geographic analysis area. Currently, there is little in terms of large hard structure outside coastal zones, so these additions would constitute a large change to existing conditions. The structures and the consequential impacts would remain at least until decommissioning of each facility is complete. In context of reasonably foreseeable environmental trends, the combined impacts of this IPF on benthic resources from ongoing and planned actions, including Alternative A, would likely be **negligible** to **minor** impacts (disturbance, injury, mortality, increased predation, habitat degradation and conversion) and **moderate beneficial** impacts (provision of hard-structure habitat).

BOEM could require Vineyard Wind, as a condition of COP approval, to use only certain types of cable protection (Appendix D). The use of natural materials and nature-inclusive designs would increase the probability of recolonization by benthic organisms and use of the introduced substrate as habitat. Therefore, this would reduce the degree of adverse impacts from cable protection and enhance the degree of possibly beneficial impacts, although the significance level of impacts would remain the same. BOEM could also require Vineyard Wind, as a condition of COP approval, to minimize foundation scour protection (Appendix D). This mitigation measure could reduce the expected impacts of habitat conversion by minimizing the area affected by scour protection, although the significance level of impacts would remain the same.

Discharges: Alternative A is not anticipated to cause any impacts on benthic resources through this IPF. Ongoing and future non-offshore wind activities may cause short-term local impacts (disturbance, reduction in fitness) through this IPF. Future offshore wind activities are expected to cause little to no impact on benthic resources through this IPF. No collective impacts of this IPF on benthic resources can be attributed to Alternative A, although future non-offshore wind activities may cause short-term local impacts. Overall, these impacts would fall within the range of impacts from ongoing activities. Any new ocean disposal sites would not overlap the corresponding impacts of Alternative A. Many discharges are required to comply with permitting standards established to ensure that discharge impacts on the environment are mitigated. There does not appear to be evidence that the anticipated volumes and extents would have any overall impact on benthic resources.

Regulated fishing effort: Regulated fishing effort can affect benthic resources by modifying the nature, distribution, and intensity of fishing-related impacts (mortality, bottom disturbance). Alternative A and other future offshore wind development could influence this IPF (Section 3.10), possibly influencing when, where, and to what degree fishing activities affect benthic resources. See Section 3.10 for the collective contribution of ongoing, future non-offshore wind, future offshore wind, and Alternative A on regulated fishing effort. The intensity of impacts on benthic resources under future fishing regulations are uncertain, but would likely be similar to, or less than, under the status quo, and would likely qualify as **moderate**.

Seabed profile alterations: During construction, Alternative A allows for up to 69 acres (0.3 km^2) of seafloor beyond the area affected by cable emplacement, potentially leading to short-term impacts including habitat alteration, injury, and mortality. However, Vineyard Wind has indicated that a need for dredging is unlikely and the company has not reserved any dredging equipment at this time. The impacts would likely be short-term, considering the natural mobility of sand waves in the WDA and OECC, although full recovery of the benthic faunal assemblage may require several years (Boyd et al. 2005). The Proposed Action would not dredge in eelgrass beds or hard-bottom habitats. Under Alternative A alone, the impacts on benthic resources from this IPF would be **minor**.

The **minor** incremental impacts (injury, mortality, short-term habitat disturbance) of Alternative A's dredging of up to 69 acres (0.3 km^2) of seafloor beyond the area affected by cable emplacement would be in addition to the seabed profile alteration impacts of the No Action Alternative. Although the amount of seabed profile alteration in the No Action Alternative is not known, assuming it is proportional to OECC length, it is likely to be on the order of 3 times more than Alternative A alone (Table A-4). In context of reasonably foreseeable environmental trends, the combined impacts of this IPF on benthic resources from ongoing and planned actions, including Alternative A, are likely to be widespread and **minor**.

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredging methods (Appendix D). This would reduce the area and degree of dredging-related impacts compared to the maximum-case scenario, possibly reducing the level of the impacts of Alternative A alone on benthic resources via seabed profile alterations.

Sediment deposition and burial: Cable laying and construction would also result in the resuspension and nearby deposition of sediments. In areas where displaced sediment is thick enough, organisms may be smothered, which would result in mortality. Certain benthic species, such as corals, may have a particularly low sensitivity threshold to sedimentation. Corals have not been reported within the WDA or OECC, although the non-reef forming star coral (*Astrangia poculata*) is known to occur in the region (COP Volume III, Section 6.5.2.1.3; Epsilon 2020b). Modeling of dredging within the OECC prior to cable installation predicted that a maximum of 329 acres (1.33 km^2) would exceed the 0.04-inch (1-millimeter) deposition threshold, and that 35 acres (0.14 km^2) would exceed the 0.79-inch (20-millimeter) threshold (COP Volume III, Appendix III-A, Table 20; Epsilon 2020b). In this conservative model, the entire route was assumed to consist of the sediment sample with the greatest relative fraction of fine material, which was approximately 23 to 29 percent; the model evaluated sediment suspension from dredging and from cable burial. Sedimentation would only exceed 0.79 inch (20 millimeters) due to dredging via TSHD, which Vineyard Wind would only use on mobile sand waves. Deposition over 0.04 inch (1 millimeter) would mostly occur within 260 to 330 feet (80 to 100 meters) of the route centerline (COP Volume III, Section 5.5.2.1; Epsilon 2020b), so the impact on benthic habitat would be limited spatially to the vicinity of the cable corridor. Modeling of offshore export cable installation predicts that, for typical installation parameters, a maximum of 2,545 acres (10.3 km^2) would exceed the 0.04-inch (1-millimeter) deposition threshold. These estimates are conservative also because they used a previous version of the OECC that was slightly longer than the maximum case currently under consideration. Modeling of inter-array cable installation predicts that, for typical installation parameters, a maximum of 598 acres (2.4 km^2) would exceed the 0.04-inch (1-millimeter) deposition threshold. For both offshore export cable and inter-array cable installation, no areas would exceed the 0.79-inch (20-millimeter) threshold.

Dredging and/or cable burial, which could cause sedimentation, would be expected to occur from April through September in the WDA and from May through June in the OECC. This timing could overlap with spawning and development of squid (Hatfield and Cadrin 2002) and sand dollars (Costello and Henley 1971), potentially leading to mortality of eggs and young in the affected areas. However, the other major benthic invertebrates, including sponges, bivalves, amphipods, sand shrimp, and polychaetes, may not be as sensitive, as they either reproduce outside of this time period or spawn several times throughout the year (Costello and Henley 1971). Sedimentation and other factors, while not significantly affecting an organism's survival, could still have impacts on other aspects of the resource, such as its quality for commercial purposes. See Section 3.3 for a discussion of commercially important species and Section 3.10 for a discussion of commercial fisheries economics. Because most lightly sedimented areas would recover naturally, and most benthic resources in the geographic analysis area are adapted to the turbidity and periodic sediment deposition that occur naturally in the geographic analysis area, BOEM anticipates that impacts on benthic resources would be **minor**.

The **minor** impacts (smothering, loss of fitness, short-term habitat degradation) of Alternative A alone would be in addition to the sediment deposition and burial impacts of the No Action Alternative. Alternative A alone would cause sediment deposition on up to 2,594 acres (10.5 km^2). Ongoing activities cause similar impacts over an unknown extent. Future offshore wind activities would also cause similar impacts over an area that is unknown but, assuming it is proportional to OECC length (Table A-4), would likely be on the order of 3 times more than Alternative A alone. In context of reasonably foreseeable environmental trends, the combined impacts of this IPF on benthic resources from ongoing and planned actions, including Alternative A, would likely be short-term to long-term and **minor**.

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredge disposal sites (Appendix D). This could minimize impacts on sensitive habitats and allow for the identification of potential remedial efforts if misplacement of materials were to occur. Although this could reduce the impacts of burial during dredged material disposal, the sediment deposition impacts described above would still occur; therefore, the significance level of impacts would remain the same.

Climate change: This IPF would contribute to alterations in ecological relationships, alterations in migration patterns, changes to disease frequency, and the reduced growth or decline of invertebrates that have calcareous shells. Because this IPF is a global phenomenon, the impacts through this IPF from planned actions, including Alternative A, would be practically the same as those under the No Action Alternative. The intensity of impacts resulting from climate change are uncertain, but are anticipated to qualify as **minor** to **moderate**.

Other considerations: The total estimated area subject to mortality of benthic resources from future offshore wind activities including Alternative A would include 3,482 acres (14.1 km^2) affected by pile-driving noise, 272 acres (1.1 km^2) affected by hard protection atop cables, 60 acres (0.2 km^2) affected by anchoring, and 1,590 acres (6.4 km^2) affected by new cable emplacement, for a total of approximately 5,404 acres (21.9 km^2), most or all of which is expected to be recolonized. Benthic communities forming after disturbance may contain different species than before disturbance, although the community may still be of the same general type (HDR 2017, 2019). In either disturbed or new habitats, ecological succession typically leads to changes in the community over time.

Heat produced by operating power transmission cables, as discussed in Section 3.2.1.1, would likely have **negligible** impacts on benthic resources.

Considerable impacts on benthic resources may also occur through IPFs not caused by the Proposed Action or other offshore wind activities. Specifically, dredging and bottom trawling are expected to contribute a continuous series of short-term local impacts across much of the geographic analysis area for benthic resources. A possible additional impact of Alternative A and other future offshore wind activities would be that benthic resources may benefit from a reduction in bottom disturbance if fishing using bottom trawls and dredge gear were to occur less within WTG arrays than under existing conditions; however, this fishing effort may simply move to other locations inside or outside the geographic analysis area for benthic resources.

In summary, activities associated with the construction and installation, operations and maintenance, and decommissioning in the WDA and OECC would impact 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 Alternative A alone would range from **negligible** to **moderate**, including the presence of structure, which may result in **moderate beneficial** impacts. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.2.1.2. The most prominent IPFs are expected to be new cable emplacement, noise from pile driving, 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 long-term impact on benthic communities from construction and installation of Alternative A alone to be **moderate**, as the effects could be measurable on a site-level scale, but not so within the entire Project area, and the resources would likely recover naturally over time. Vineyard Wind may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above, but doing so would not likely result in different impact ratings than those described above.

In context of reasonably foreseeable environmental trends, the impacts resulting from individual IPFs from ongoing and planned actions, including Alternative A, would range from **negligible** to **moderate** (with the exception of the **major** risk of accidental releases of invasive species, which is driven mostly by ongoing activities) and **moderate beneficial**. Considering all the IPFs together, BOEM anticipates that the overall impacts from ongoing and planned actions, including Alternative A, would include **moderate** impacts and **moderate beneficial** impacts to benthic resources in the geographic analysis area. The main drivers for this impact rating are bottom temperature changes due to ongoing climate change, ongoing recurring bottom disturbance from bottom-tending fishing gear, mortality resulting from offshore construction, and the beneficial presence of structures. Alternative A would contribute to the overall impact rating primarily through the temporary impacts due to new cable emplacement and permanent impacts from the presence of structures (cable protection measures and foundations). BOEM has considered the possibility of a **major** impact resulting from invasive species; this level of impact could occur if an invasive species were to adversely impact 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. Invasive species have already been documented on Georges Bank, and the risk of impacts within the benthic resources analysis area would be highly similar under the No Action Alternative or under Alternative A, as ongoing activities (e.g., shipping and marine debris) contribute most of the risk through this IPF. Thus, the overall impacts on benthic resources would likely qualify as **moderate** because a notable and measurable adverse impact is anticipated, but most resources would likely recover when the impacting agents were gone and remedial or mitigating actions were taken. Although some of the proposed activities and/or IPFs analyzed could overlap, BOEM does not anticipate that this would alter the overall impact rating.

Vineyard Wind has signed an agreement with non-government organizations to implement enhanced mitigation (Vineyard Wind et al. 2019). The agreement includes a promise to install no more than two jacket foundations, which would result in less installation impact than under the maximum case otherwise. However, this would not change the level of impacts to benthic resources. See COP Table 4.2-1 for other measures that Vineyard Wind would implement to reduce potential impacts on benthic resources (Volume III; Epsilon 2020b). In addition, MassDEP, pursuant to the Town of Nantucket wetlands protection bylaw, has instituted the following requirements for the portion of the proposed work in Nantucket waters: (1) Vineyard Wind must obtain the approval of MassDEP for the final benthic monitoring plan, (2) Vineyard Wind must provide an updated bottom profile survey including video documentation, (3) any cable armoring must consist of natural materials that mimic the surrounding seafloor, (4) a post-construction survey and annual reporting must demonstrate any impacts, (5) if a report shows any adverse impact, Vineyard Wind must provide a detailed mitigation or restoration plan. See Appendix D for details.

BOEM is considering various mitigation and monitoring measures developed through EFH consultation with NMFS, through coordination with other federal and state agencies, and in response to comments received on the DEIS and SEIS. BOEM could require, as a condition of COP approval, initiatives to ensure benthic community monitoring (Appendix D); BOEM could also require that Vineyard Wind consult relevant resource management agencies before finalizing and implementing this monitoring. BOEM is considering requiring Vineyard Wind to document the locations of dredged material disposal (Appendix D). Vineyard Wind has also already committed to performing turbidity monitoring and an as-built survey of cable location and depth of burial (Epsilon 2018c). Other mitigation measures were considered (e.g., time-of-year restrictions). Given that Vineyard Wind has committed to avoiding spring and summer cable burial activities in Nantucket Sound (Section 1.2.4; Epsilon 2019a), additional time-of-year restrictions on cable laying and burial may not be warranted or feasible due to weather conditions and other factors in the offshore environment. For example, NMFS has previously determined that up to 81 trawling vessels in a single month in a single offshore statistical area had no effect on squid EFH (NOAA 2011). The level of seafloor disturbance in the proposed Project would be substantially less than that level of trawling disturbance and, therefore, should also have less than significant effects. Finally, BOEM could require all vessels deploying anchors to use mid-line anchor buoys whenever feasible and safe to reduce the amount of anchor chain/line that touches the seafloor (Appendix D). BOEM is considering the types of materials allowed as cable protection in hard-bottom habitat, and is also considering requiring Vineyard Wind to consider nature-inclusive designs for optimized cable protection (Hermans et al. 2020). While any or all of these additional measures would tend to reduce impacts, the overall significance level of impacts would remain the same even if they were all required as a condition of COP approval.

3.2.3. Consequences of Alternatives C, D1, and D2

The only relevant change from Alternative A to Alternative C is the exclusion of six WTGs in the northern/northeasternmost portion of the WDA, and the relocation of the WTGs and their inter-array cables to the southern portion of the WDA. The only relevant change for Alternative D1 from Alternative A would be the location of the WTGs and inter-array cables, which would be spaced to a minimum of 1 nautical mile apart. The only relevant change of Alternative D2 from the Proposed Action would be the arrangement of the WTGs and inter-array cables within the WDA. Prior to construction, additional geotechnical and/or engineering surveys (necessary to determine the new WTG placements) may result in a small, temporary increase in vessel use and bottom disturbance unaccounted for in the Proposed Action. BOEM anticipates that this disturbance would be brief and localized, particularly compared to other proposed-Project activities, and have **negligible** impacts.

The surface sediment of the WDA is soft-bottom habitat with sand waves, though there are some coarser-grained sediments below the surface at depths of 60 feet (18 meters) or greater, mostly in the southwestern end of the WDA (COP Volume III, Section 5.3; Epsilon 2020b). The character of the sediment changes throughout the WDA; depths greater than 98.4 feet (30 meters) are predominantly fine sand with some silt, and generally become finer grained as depth increases. Figure 1 in COP Appendix F (Volume II-A; Epsilon 2018a) depicts the trend of increasing water depth from north to south. The northernmost point of the WDA is approximately 118 feet (36 meters) deep, while parts of the southern end of the WDA reach approximately 164 feet (50 meters) deep. Both depth and sediment type are characters that influence benthic assemblages; it is therefore possible that relocation of WTGs would affect slightly different benthic communities (although with overall similar composition) (COP Volume II-A, Appendices H-3 and H-5; Epsilon 2018a). However, the impact on these communities is not anticipated to exceed the impacts in Alternative A, given that all construction methods would be the same, and that the benthic invertebrate assemblages found in the southern portions of the WDA are similar to the assemblages in the northern portions of the WDA (COP Volume II-A, Appendix H-4; Epsilon 2018a). Ultimately, the overall level of impact and the level of each IPF are anticipated to be the same as under Alternative A (individual IPFs ranging from **negligible** to **moderate** and **moderate beneficial**).

It is unlikely that Alternative A would use the maximum amount of inter-array cable identified in the maximum-case scenario; therefore, Alternatives D1 and D2 may use more inter-array cable (because of the wider spacing of WTGs) than Alternative A and may have a greater footprint on benthic resources (due to bottom disturbance). Recent forecasts by Vineyard Wind estimate that the length of inter-array cabling would be approximately 186.4 miles (300 kilometers) under Alternative D1 or D2, which exceeds the maximum design parameter in the COP PDE of 171 miles (275 kilometers). However, the degree of impact on benthic communities, and the overall impact of Alternatives D1 and D2 on benthic resources would be the same as under Alternative A (individual IPFs ranging from **negligible** to **moderate** and **moderate beneficial**). In context of reasonably foreseeable environmental trends, the impacts from ongoing and planned actions, including Alternatives C, D1, and D2, would be similar to those under Alternative A (with individual IPFs leading to impacts ranging from **negligible** to **moderate** and **moderate beneficial** and an overall impact rating of **moderate**). 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.

The potential additional mitigation measures identified above would also be applicable to these alternatives.

3.2.4. Consequences of Alternative E

Under Alternative E, the proposed Project footprint would be considerably less than under the maximum-case scenario under Alternative A, due to the reduced number of WTGs and associated reduction in inter-array cabling. By using 84 of the potential 100 turbine placements proposed by Vineyard Wind, Alternative E would impact approximately 16 percent less of the local benthic area within the WDA. The maximum footprint of the WTG and ESP foundations and associated scour protection would be approximately 45 acres (0.2 km^2), which is an 8-acre (32,375 m^2) reduction (7.0 percent) compared to Alternative A. In actuality, the footprint could be slightly smaller, since there could be a reduced amount of inter-array cabling and presumably a reduction in the necessary amount of cable protection within the WDA. Impacts associated with WTG installation, including pile driving, temporary habitat disturbance, turbidity, and sediment deposition, would also be reduced by approximately 16 percent, decreasing the overall impacts on benthic resources in the WDA. Impacts related to the offshore export cable would be the same as under Alternative A.

The impact of Alternative E on benthic resources would be the same as or less than the impact of Alternative A. Alternative E would reduce the footprint of the WTGs and cabling within the WDA, and there would be an assumed reduction in associated vessel use and maintenance activities. If additional surveys are necessary, they should have a **negligible** impact on benthic resources.

In context of reasonably foreseeable environmental trends, while Alternative E may be slightly less impactful to benthic resources than Alternative A, the combined impacts from ongoing and planned actions, including Alternative E, would be similar to the those under Alternative A (with individual IPFs leading to impacts ranging from **negligible** to **moderate** and **moderate beneficial** and an overall impact rating of **moderate**). 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. The potential additional mitigation measures identified above would also be applicable to this alternative.

3.2.5. Consequences of Alternative F

Alternative F analyzes a vessel transit lane through the WDA, in which no surface occupancy would occur. BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area

(OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. The WTGs that would have been located within the transit lane would not be eliminated from Alternative A; instead, the displaced WTGs would be shifted to locations south within the lease area. Under this alternative, BOEM is analyzing a 2- and 4-nautical-mile northwest/southeast vessel transit lane through the WDA combined with any action alternative; however, this analysis focuses on the combination of Alternative F with either the Alternative A or Alternative D2 layout. Therefore, the number of turbines would remain the same. The northern transit lane within the WDA could result in the relocation of 16 to 34 WTG placements, an increased extent of inter-array cables, and a 12 to 61 percent increase in the size of the WDA, depending on whether the Alternative A or Alternative D2 layout is used, and how wide the transit lane is. All other design parameters and potential variability in design would be the same as under Alternative A or Alternative D2. Any potential variances in the proposed-Project build-out as defined in the PDE (i.e., numbers of WTGs and ESPs) or construction activities would result in similar or lesser impacts than described above.

The impacts of Alternative F alone on benthic resources would be greater than those of Alternative A alone (though of a similar level) because the length of inter-array cabling would increase and would exceed the maximum design parameter in the COP PDE of 171 miles (275 kilometers) due to the need to traverse a 2- or 4-nautical-mile transit lane; the seafloor area affected in the course of inter-array cable installation and operations and maintenance would also increase. Recent forecasts by Vineyard Wind estimate that the length of inter-array cabling would be approximately 221 miles (355 kilometers) under Alternative F with a 4-nautical-mile transit lane and the Alternative A layout, and 234 miles (376 kilometers) with a 4-nautical-mile transit lane and the Alternative D2 layout; if the transit lane were only 2 nautical miles wide, the length of inter-array cabling would still exceed that in the COP PDE but would be somewhat less than with a 4-nautical-mile transit lane. Additional site characterization surveys may cause local temporary impacts that are difficult to detect. As stated previously, the geographic analysis area for benthic resources extends for a 10-mile (16.1-kilometer) radius around the WDA and the OECC proposed in the COP. As a result, and because WTGs would be relocated further south of the WDA as a result of the transit lane, Alternative F in combination with any other alternative or combination of alternatives would expand the area of potential effect for benthic resources. Slight changes in benthic communities could occur with changing location and depth in a different portion of the lease area, but BOEM anticipates these changes to be insignificant, based on the similarity of sediments and invertebrate communities across the WDA (COP Volume II-A, Appendix H-4; Epsilon 2018a). Therefore, expanding the WDA and shifting some activities and structures to the south/southwest would not likely affect different benthic resources or change the nature of potential impacts on benthic resources. For the same reason, the potential impacts on benthic resources of Alternative F do not depend on the other turbine layout constraints (Alternatives A, D2, or any other alternative) or on the width of the transit lane (2 or 4 nautical miles), with the exception that a greater amount of cable would lead to greater impacts. While Vineyard Wind would have the liberty to configure the inter-array and inter-link cables within the bounds established by the final approved COP, the minimum cable length technically necessary to connect enough WTGs to meet the 800 MW generation capacity in the COP would likely be shortest for a 2-nautical-mile transit lane combined with the layout of Alternative A (or Alternative E) and the longest for a 4-nautical-mile transit lane combined with the Alternative D2 layout. In other respects, the impacts of Alternative F alone would be similar to those of Alternative A. The impacts of Alternative F alone on benthic resources would likely be **moderate**, including the presence of structure, which may result in **moderate beneficial** impacts. The potential additional mitigation measures identified above would also be applicable to this alternative.

Because the transit lanes are generally not oriented to existing fishing patterns (see details on commercial fishing in Section 3.10.2.6), it is not anticipated that there would be a substantial increase in the utilization of bottom-tending fishing gear in the transit lane. Thus, the difference in benthic impacts resulting from commercial fishing activity between Alternative F and Alternative A would likely be biologically insignificant in relation to existing commercial fishing activity in the geographic analysis area.

In considering the collective impacts of Alternative F among other planned actions, BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. In context of other reasonably foreseeable environmental trends, the combined impacts from planned actions, including

Alternative F, would be similar to those under Alternative A (with individual IPFs leading to impacts ranging from **negligible** to **moderate** and **moderate beneficial** and an overall impact rating of **moderate**).

BOEM has qualitatively evaluated the collective impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. To the extent additional transit lanes are implemented in the future outside the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located farther from shore, similar to the proposed Project under Alternative F. As a result, establishment of additional transit lanes could require increased lengths of offshore export cable and therefore increased effects on benthic resources. This could result in some activities that are uncertain and may lead to greater, lesser, or similar impacts on benthic resources. Any project that is intersected by a transit lane would likely require an increased amount of inter-array cable leading to increased benthic disturbance. However, the addition of the transit lanes would also lead to fewer permanent structures (e.g., foundations and scour protection), which would decrease benthic impacts, thus reducing the extent of permanent impacts to benthic resources.

3.2.6. Comparison of Alternatives

As discussed above, the impacts associated with Alternative A alone do not change substantially under Alternatives C through F. Although the amount of impacts from cabling varies slightly among alternatives, the level of impacts would be similar for these alternatives. Alternative E has the potential for the least impact on benthic resources due to the reduced footprint within the WDA. Alternative F would have impacts on benthic resources that would be greater than those of Alternative A because the length of inter-array cabling would increase. Furthermore, in context of other reasonably foreseeable environmental trends, the overall impact of any action alternative when combined with other planned actions would be similar because the majority of the impacts result from ongoing activities and other future offshore wind projects. See Table 2.4-1 for a comparison of alternative impacts.

3.2.7. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. Thus, no WTGs or inter-array cable would be placed within the northernmost portion of the WDA; more WTGs and inter-array cable may be placed in the southern portion of the WDA and may extend beyond the limits of the WDA proposed in the COP, although not beyond the boundaries of Lease Area OCS-0501; and no more than 84 WTGs would be allowed. Under the Preferred Alternative, the footprint should be considerably less than under Alternative A, due to the reduced number of WTGs and associated inter-array cabling in the Preferred Alternative. By installing no more than 84 WTGs, the Preferred Alternative would impact approximately 16 percent less of the local benthic communities within the WDA from the reduction in the number of WTGs and associated scour protection. The maximum footprint of the WTG and ESP foundations and associated scour protection would be approximately 45 acres (0.2 km^2), which is an 8-acre (32,375 m^2) reduction compared to the maximum case under Alternative A. Impacts associated with WTG installation, including pile driving, temporary habitat disturbance, turbidity, and sediment deposition would also be reduced by approximately 16 percent, decreasing the overall impacts on benthic resources in the WDA. The length of inter-array cabling would be approximately 186.4 miles (300 kilometers), which exceeds the maximum design parameter in the COP PDE of 171 miles (275 kilometers) (Michael Clayton, Pers. Comm., March 24, 2020).

The Preferred Alternative incorporates all the mitigation and monitoring measures listed in Appendix D for this resource. These mitigation measures may reduce impacts on benthic resources, but would not necessarily change the impact ratings (Appendix D). The monitoring measures would not reduce the impacts of the Preferred Alternative compared to Alternative A; however, information gained via monitoring could be used to inform Vineyard Wind's decommissioning procedures, and could be used by others planning similar future projects, to assist in selecting the least impactful method(s). Other mitigation measures were considered (e.g., time-of-year restrictions). Given that Vineyard Wind has committed to avoiding springtime cable burial activities in Nantucket Sound (Section 1.2.4; Epsilon 2019a), additional time-of-year restrictions on cable laying and burial may not be warranted or feasible due to weather conditions in the offshore environment. Also in the offshore environment, NMFS has previously determined that up to 81 trawling vessels in a single month in a single statistical area had no effect on squid EFH (NOAA 2011).

Vineyard Wind's signed Agreement with non-government organizations to implement enhanced mitigation would further reduce effects. The Agreement includes a commitment to install no more than two jacket foundations, which could result in slightly less installation impacts when compared to the maximum case. However, the Agreement would not change the level of impacts on benthic resources. In addition, MassDEP, pursuant to the Town of Nantucket wetlands protection bylaw, has instituted the following requirements of Vineyard Wind for the portion of the proposed work in Town of Nantucket waters: (1) obtain the approval of MassDEP for the final benthic monitoring plan, (2) provide an updated bottom profile survey including video documentation, (3) any cable armoring must consist of natural materials that mimic the surrounding seafloor, (4) a post-construction survey and annual reporting must demonstrate any impacts, and (5) if a report shows any adverse impact, Vineyard Wind must provide a detailed mitigation or restoration plan. See Appendix D for details.

Overall, with the exception of the No Action Alternative, the Preferred Alternative would likely result in the least impact on benthic resources of the alternatives analyzed, and would result in an impact level of **moderate**.

Impacts due to operations and maintenance as well as decommissioning of Preferred Alternative would be highly similar to those of Alternative A. Furthermore, operations and maintenance may result in less routine vessel use and preventive maintenance during the life of the proposed Project due to the reduction in number of turbines.

3.3. Finfish, Invertebrates, and Essential Fish Habitat

3.3.1. No Action Alternative and Affected Environment

This section discusses existing finfish, invertebrate resources, and designated EFH in the geographic analysis area for finfish, invertebrates, and EFH as described in Table A-1 in Appendix A and shown on Figure A.7-4, namely, U.S. waters of the Northeast U.S. Shelf Large Marine Ecosystem (LME). Table 3.3-1 describes baseline conditions and the impacts, based on the IPFs assessed, of ongoing and future activities other than offshore wind, which is discussed below. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (50 C.F.R. Part 600). Pursuant to scoping comments from NMFS (April 7, 2018), BOEM prepared an expanded EFH assessment for Alternative A (BOEM 2019e), as well as a new addendum to evaluate changes to the PDE and the new Alternative F (BOEM 2020e). This section summarizes and discusses the assessment's key findings and incorporates the entire assessment by reference. Appendix F, Section F.6, contains further discussion of EFH conservation recommendations from NMFS and BOEM's response. The following are agencies, commissions, councils, and regulations responsible for managing the finfish, invertebrates, and EFH in the analysis area:

- The Atlantic States Marine Fisheries Commission (ASMFC) is responsible for managing or co-managing 27 coastal shellfish, marine, and diadromous fish species in state waters in cooperation with NOAA (ASMFC 2018c).
- The New England and Mid-Atlantic Fishery Management Councils manage a total of 40 species in federal waters in cooperation with NOAA.
- NOAA uses a single Fisheries Management Plan (FMP) under the MSA (NOAA 2018b) to manage 43 Atlantic highly migratory species (HMS) in the Exclusive Economic Zone (EEZ), which extends from the 3nautical-mile limit to the 200 nautical-mile limit.
- Section 7(a)(2) of the ESA requires federal agencies to ensure that any action they authorize, fund, or carry out is unlikely to jeopardize an endangered or threatened species, in consultation with the relevant agency(ies). NOAA has identified four listed species and 15 Candidate Species or Species of Concern as potentially occurring in the WDA and OECC (BOEM 2019d, 2020a).
- Section 305(b)(2) of the MSA requires federal agencies to consult with NMFS regarding any of their actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect EFH (50 C.F.R. § 600.920).

This section provides a qualitative assessment of the impacts of each alternative on finfish and invertebrates. This section does not quantitatively assess ESA Candidate Species, Species of Concern, or individual fish stocks. More detailed information regarding the impact on ESA-listed fish and on EFH can be found in the biological assessment

(BA) submitted to NMFS (BOEM 2020d) and the EFH assessment (BOEM 2019e, 2020b), respectively. A discussion of commercial fisheries and for-hire recreational fishing can be found in Section 3.10.

The WDA and OECC are located within the southern New England sub-region of the Northeast U.S. Shelf LME, which extends from the Gulf of Maine to Cape Hatteras, North Carolina (BOEM 2014b). This sub-region differs from others in productivity, species assemblages and structure, and habitat features (Cook and Auster 2007). Sandy substrate dominates, a characteristic reflected in the finfish and invertebrate species assemblages found in the WDA and OECC. This region has a very diverse and abundant fish assemblage that can be generally categorized according to life habitats or preferred habitat associations (e.g., pelagic [inhabit the water column], demersal [bottom feeders], resident, and HMS). Some species of commercial, recreational, or ecological importance are listed in Table E.5-2 in Appendix E, along with where they can be found and their current condition. Many species vary in abundance and distribution across seasons. Many of these species are federally managed species, meaning they have a designated EFH. EFHs define important marine and diadromous (migratory between salt and fresh waters) fish habitat for all federally managed finfish and invertebrate species mandated through the MSA (50 C.F.R. Part 600) (BOEM 2019e). There are also finfish and invertebrates listed under the ESA, although only four of those species (Atlantic sturgeon [*Acipenser oxyrinchus oxyrinchus*], shortnose sturgeon [*Acipenser brevirostrum*], Atlantic salmon [*Salmo salar*], and giant manta [*Manta birostris*]) are likely to occur in the region surrounding the proposed Project. Candidate species and species of concern include 15 marine and diadromous fish, many of which are commercially and recreationally valuable (e.g., bluefin tuna [*Thunnus thynnus*], alewife [*Alosa pseudoharengus*] [BOEM 2019d, 2020a]); however, none are currently proposed to be listed under the ESA.

The main demersal fishes found in the region are either shallow or intermediate finfish assemblages (Overholtz and Tyler 1985; see Table 4-8 in BOEM 2014b). Many of these species are common to shallow and intermediate finfish assemblages and are thought to be important in the commercial and recreational fishing industry, or are considered of special concern due to depleted regional populations (BOEM 2014b). Many of the pelagic species in the Southern New England sub-region are valuable commercial or recreational fishes. Furthermore, there are numerous federally managed pelagic invertebrate species found in the region, as well as some demersal and benthic species (Appendix E, Table E.5-2). The region also contains finfish and invertebrates that are not federally managed (i.e., no EFH), but that provide a valuable resource to the food web and species that do have designated EFH, or are of recreational or commercial value. COP Table 6.6-1 also lists a summary of the main finfish and invertebrate species identified in the vicinity of the proposed Project (Volume III, Section 6.6.1; Epsilon 2020b).

Studies identifying the most prevalent species regionally include the 2003 to 2016 New England Fishery Science Center (NEFSC) bottom trawl surveys as summarized in Guida et al. (2017) and trawl surveys (1978 to 2018) conducted by the MA DMF. The NEFSC identified 101 taxa, including 40 managed species (Guida et al. 2017). Dominant species in both cold (winter/spring) and warm seasons (fall) included little skate (*Leucoraja erinacea*), winter skate (*Leucoraja ocellata*), and silver hake (*Merluccius bilinearis*). Summer/fall dominant species included longfin squid (*Doryteuthis pealeii*), spiny dogfish (*Squalus acanthias*), red hake (*Urophycis chuss*), Atlantic butterfish (*Peprilus triacanthus*), and scup (*Stenotomus chrysops*), while winter dominant species included Atlantic herring (*Clupea harengus*) (Guida et al. 2017). All of these species have designated EFH within the region (COP Volume III, Appendix F; Epsilon 2020b; BOEM 2014b). Large bivalves, such as Atlantic surfclams (*Spisula solidissima*), Ocean quahog (*Arctica islandica*), and Atlantic sea scallops (*Placopecten magellanicus*), are also present, although their abundances are less well known (Powell and Mann 2016; Powell et al. 2017; SMAST 2016); however, recent assessments indicate that none of these three species is currently subject to overfishing or in an overfished condition (MAFMC 2020a, 2020b; NEFSC 2018a).

The American lobster (*Homarus americanus*) (southern New England stock) is present in this region and the waters south of Massachusetts contain important commercial lobster fishing grounds. However, catches in southern New England have declined sharply since the late 1990s, with the largest declines occurring in the inshore fishery (Figure 1.1 in ASMFC 2015a; this figure shows statistical area 538, which includes large portions of the OECC, and statistical areas 539 and 611, which are outside of the WDA and OECC). The commercial importance of other species, like whelks and Jonah crab (*Cancer borealis*), has increased with the decline of the American lobster fishery, with Massachusetts accounting for 68 percent of the 15 million pounds of Jonah crab landed in 2016 (ASMFC 2015b). More than 70 percent of the Jonah crab catch landed in southern New England came from the region that includes portions of the WDA and OECC (statistical area 537 of Figure 4 in ASMFC 2015b). Jonah crab are typically associated with rocky habitats as well as soft sediment, while lobster prefer hard-bottom habitat (ASMFC 2015a; Collie and King 2016). Only small amounts of hard-bottom habitat exist in the WDA and OECC, and the WDA (75,520 acres [306 km^2]) amounts to only 1.4 percent of statistical area 537 (5,309,419 acres [21,487 km^2]). Other commercially important species are listed in Table E.5-2 in Appendix E.

The WDA lies within a region south of Martha's Vineyard (northern Mid-Atlantic Bight) and the OECC extends north through Muskeget Channel to landfall in south-central Cape Cod, Massachusetts (COP Volume III, Section 6.6.1; Epsilon 2020b). The benthic habitat in the WDA is predominantly flat with sand or sand-dominated substrate that becomes increasingly muddy toward the south end of the WDA and increasingly gravelly toward the northwest corner (Guida et al. 2017). Chart 2 in COP Volume II-A, Appendix II-I, provides an overview of the bathymetry within the WDA (Epsilon 2018a). The MA DMF spring and fall trawl surveys included sampling locations specific to the WDA (Figure 1, Region 2, in King et al. 2010). MA DMF identified a total of 85 species (or higher taxa) during spring sampling (1978 to 2018) and 115 taxa during fall sampling (1978 to 2017). The top five most commonly encountered species in spring samples based on percent occurrence in descending order were spider crabs (Majidae), longfin squid, winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), and northern sea robin (*Prionotus carolinus*). During fall sampling, the most commonly encountered species were scup, longfin squid, Atlantic butterfish, black sea bass (*Centropristis striata*), and spider crabs (Matt Camissa, Pers. Comm., July 25, 2018).

HMS with ranges overlapping the WDA and OECC are identified and described in BOEM (2014a) and the COP (Volume III, Section 6.6.1.1; Epsilon 2020b). Several of these HMS have designated EFH within the WDA and OECC (Appendix E, Table E.5-2). HMS are discussed in detail in the EFH assessment (BOEM 2019e, 2020b). NEFSC captured a total of 71 taxa during the winter/spring trawl and 81 taxa in the summer/fall trawl (Guida et al. 2017), indicating the WDA is located within an area of relatively high species richness, as shown in COP Figure 6.6-1 (Volume III, Section 6.6.1.1; Epsilon 2020b). Biomass is low across the WDA (COP Volume III, Figure 6.6-2; Epsilon 2020b).

The finfish and invertebrate resources identified in the MA DMF OECC trawl surveys vary seasonally, with commercial species like longfin squid and winter flounder more prevalent in the spring, and scup, longfin squid, and butterfish more commonly captured in the fall (Matt Camissa, Pers. Comm., July 25, 2018). Longfin squid occurred in 89.6 percent of the spring surveys (1978 to 2018) and in 99.7 percent of the fall surveys (1978 to 2007). Longfin squid are typically most abundant in southern New England in the spring through fall, whereas shortfin squid juveniles are typically found in spring and summer (BOEM 2014b). Longfin squid in this region spawn throughout the summer and early fall (MA DMF 2020). Longfin squid egg mops, which are demersal, were more prevalent during spring surveys, (8.2 percent occurrence) than in fall surveys (5.5 percent occurrence) (Matt Camissa, Per. Comm., July 25, 2018). Egg mop mapping by MA DMF indicates that egg mops are routinely identified along the OECC route (COP Volume III, Section 6.6, Figures 6.6-8, 6.6-9; Epsilon 2020b).

The WDA and OECC contain at least one life stage of a total of 47 federally managed finfish and invertebrate species with EFH designation (at least one life stage for 42 species along the OECC and 46 in the WDA [BOEM 2019e]). Furthermore, Habitat Areas of Particular Concern (HAPCs) are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation (50 C.F.R. Part 600). The EFH assessment also includes HAPC for adult and juvenile summer flounder (*Paralichthys dentatus*) and inshore juvenile Atlantic cod (*Gadus morhua*) for portions of the OECC (BOEM 2019e). HAPC designations for adult and juvenile summer flounder include areas of macroalgae, seagrasses, or freshwater and tidal macrophytes in any size bed or in loose aggregations (NOAA 2018d); some of these habitat types are located within the OECC. In October 2017, the New England Fishery Management Council established a new juvenile Atlantic cod HAPC for the New England coastline out to a depth of 66 feet (20 meters) (NEFMC 2017). In scoping comments, (April 27, 2018) NMFS indicated that these measures were approved on January 3, 2018, and implemented on April 9, 2018. This HAPC for juvenile Atlantic cod is a subset of EFH for juvenile Atlantic cod, which consists of structurally complex habitats, including eelgrass, mixed sand and gravel, rocky habitats, and emergent epifauna (NEFMC 2017). The HAPC for juvenile Atlantic cod includes all hard-bottom habitats within the OECC (BOEM 2019e). The EFH assessment shows the intersection of the OECC cable route with the juvenile Atlantic cod HAPC and mapped hard bottom (Figure 1 in BOEM 2019e). Given that the juvenile Atlantic cod HAPC includes other habitat types in addition to those mapped by Vineyard Wind, the total area of juvenile Atlantic cod HAPC present in the OECC is not known, but assumed to occur along the entire cable route from the 65.6-foot (20-meter) depth contour to shore. Overall, the proportion of juvenile cod HAPC within the OECC is small considering the entire HAPC extends from the Canadian border to southern New England (map 245 in NEFMC 2017).

Using the best available data, the only two ESA-listed finfish or invertebrate species likely to occur in the WDA and OECC are Atlantic sturgeon and giant manta ray, which are discussed in detail in BOEM (2020d), hereby incorporated by reference.

Finfish, invertebrates, and EFH in the geographic analysis area are subject to pressure from ongoing activities, especially harvest, bycatch, water-quality issues, dredging and bottom trawling, and climate change. In the early 2000s, the majority of commercially exploited stocks in this ecosystem were categorized as overfished. A 2015 assessment of 20 groundfish species in the Southern New England sub-region indicates that while the number of overfished stocks has generally decreased, depletion continues for certain stocks (NEFSC 2015). In particular, winter flounder, yellowtail flounder (*Limanda ferruginea*), and Atlantic wolffish (*Anarhichas lupus*) remain overfished (NEFSC 2015). According to the most recent assessment, in the New England and Mid-Atlantic regions, 17 fish stocks are in an overfished condition and 5 are currently subject to overfishing (NOAA 2020j). The understanding and rebuilding of finfish and invertebrate stocks are complicated by variables such as long-term shifts occurring at the base of the food web (Perretti et al. 2017) and warming ocean temperatures (Hare et al. 2016). Regional water temperatures that increasingly exceed the thermal stress threshold (20°C) may affect the recovery of the American lobster stock (ASMFC 2015a). Water-quality impacts from ongoing onshore and offshore activities affect nearshore habitats and food webs. Dredging for navigation, marine minerals extraction, and/or military uses, as well as commercial fishing using bottom trawls and dredge fishing methods, disturbs seafloor habitat on a recurring basis. Commercial and recreational fishing using other methods results in mortality of finfish and invertebrates through harvest and bycatch. Commercial and recreational fishing gear are periodically lost, but they can continue to capture or otherwise harm finfish and invertebrates; the lost gear, moved by currents, create small, short-term, localized impacts. Ongoing impacts resulting from fishing pressure, especially via dredging and bottom-trawling gear, will continue regardless of the offshore wind industry. Dredging for navigation, marine minerals extraction, and/or military uses disturbs swaths of seafloor habitat. Their impacts are similar in nature but much greater in extent (spatially and temporally) than those caused by other bottom-directed IPFs such as pipeline trenching or submarine cable emplacement that create a relatively narrow trench and backfill in the same operation. Invasive species are periodically released accidentally during ongoing activities, including the discharge of ballast water and bilge water from marine vessels; the resulting impacts on finfish, invertebrates, and EFH depend on many factors, but can be widespread and permanent, especially if the invasive species becomes established and out-competes native fauna.

3.3.1.1. Future Offshore Wind Activities (without the Proposed Action)

BOEM expects future offshore wind development activities to affect finfish, invertebrates, and EFH through the following primary IPFs.

Accidental releases: Accidental releases may increase as a result of future offshore wind activities. Section A.8.2 discusses the nature of releases anticipated. The risk of any type of accidental release would be increased primarily during construction, but also during operations and decommissioning of offshore wind facilities.

See Section A.8.2 for details regarding the risk of accidental releases of fuel/fluids/hazmat. Using the assumptions in Table A-4 in Appendix A, there would be a low risk of a release from any of 2,021 WTGs and 45 ESPs, with a total of approximately 13.1 million gallons (49.6 million liters) of fuel/fluids/hazmat contained in all offshore wind facilities. According to BOEM's modeling (Bejarano et al. 2013), a release of 128,000 gallons (484,532.7 liters) 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 ESPs 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. Based on these rates, the additional impact of releases from future offshore wind facilities, the risk of which would primarily exist during construction, but also during operations and decommissioning, would fall within the range of accidental releases that already occur on an ongoing basis.

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. The impacts of releases of invasive species on finfish, invertebrates, and EFH depend on many factors, but could be widespread and permanent. Releases of invasive species may or may not lead to the establishment and persistence of invasive species. Invasive species becoming established as a result of offshore wind activities is possible. As documented in observations of a colonial tunicate (*Didemnum vexillum*) at the Block Island Wind Farm (HDR 2020), the impacts of invasive species on finfish, invertebrates, and EFH could be strongly adverse, widespread, and permanent if the species were to become established and out-compete native fauna or adversely modify habitat. The increase in this risk related to the offshore wind industry would be small in comparison to the risk from ongoing activities. For example, *Didennum* is already an established species in New England with documented occurrence in subtidal areas, including on Georges Bank, where numerous sites within a 56,834-acre (230 km^2) area are 50 to 90 percent covered by *Didemnum* sp. (Bullard et al. 2007).

Overall, accidental releases are anticipated to be short-term and localized, and to result in little change to finfish, invertebrates, and EFH. As such, accidental releases from future offshore wind development would not be expected to contribute appreciably to overall impacts on finfish, invertebrates, and EFH.

Anchoring: Vessel anchoring can cause temporary to permanent impacts in the immediate area where anchors and chains meet the seafloor. In addition, anchoring and mooring of met towers or buoys could be increased. Anchoring would cause increased turbidity levels and would have the potential to cause mortality of finfish and invertebrates and, possibly, degradation of sensitive habitats. The actual impact of each anchoring event would depend on location, habitat type, and time of year. Impacts on finfish, invertebrates, and EFH are greatest for sensitive EFH (e.g., eelgrass, hard bottom) and sessile or slow-moving species (e.g., corals, sponges, and sedentary shellfish). In the expanded offshore wind scenario, there would be increased anchoring of vessels during survey activities and during the construction, installation, maintenance and decommissioning of offshore components. Using the assumptions in Table A-4 in Appendix A, anchoring of vessels during cable installation could affect up to approximately 276 acres (1.1 km^2) over the next 10 years. All impacts would be localized, turbidity would be temporary, and mortality from physical contact would be recovered in the short term. Degradation of sensitive habitats, if it occurs, could be long-term to permanent. Anchoring is a series of separate events, each affecting only a small area of seafloor; therefore, even when multiple projects in a region occur simultaneously or consecutively, it is unlikely that a second anchor or chain would hit a portion of seafloor affected by an earlier anchor or chain.

EMF: Biologically significant impacts on finfish, invertebrates, and EFH have not been documented for EMF from AC cables (CSA Ocean Sciences, Inc. and Exponent 2019; Thomsen et al. 2015). In the United States, behavioral impacts have been documented for benthic species (skate and lobster) near operating direct current cables (Hutchison et al. 2018, 2020). The impacts are localized and affect the animals only while they are within the EMF. There is no evidence to indicate that EMF from undersea AC power cables adversely affects commercially and recreationally important fish species within the southern New England area (CSA Ocean Sciences, Inc. and Exponent 2019). A recent review concludes that recent research has demonstrated responses to EMF in various species, but not at the EMF strengths involved in marine renewable energy projects (Gill and Desender 2020). Operating cables related to future offshore wind activities other than the proposed Project would produce EMF to some degree. The cable routes for those projects have not been determined at this time. In the expanded offshore wind scenario, up to 5,947 miles (9,571 kilometers) of cable would be added in the geographic analysis area for finfish, invertebrates, and EFH, producing EMF in the immediate vicinity of each cable.

Submarine power cables in the geographic analysis area for finfish, invertebrates, and EFH are assumed to be installed with appropriate shielding and burial depth to reduce potential EMF resulting from cable operation to low levels. EMF of any two sources would not overlap because developers typically allow at least 330-foot (100-meter) spacing between cables (even for multiple cables within a single OECC), EMF strength diminishes rapidly with distance, and potentially meaningful EMFs would likely extend less than 50 feet (15.2 meters) from each cable. A migrating individual may encounter EMF on multiple occasions, each time potentially experiencing a behavioral impact during the time it is exposed to the EMF. Most exposures are expected to last for minutes, not hours, and the affected area would represent only a tiny portion of the available habitat for most migratory species, many of which travel several miles in a day (CSA Ocean Sciences, Inc. and Exponent 2019). EMF does not appear to constitute a barrier to migration (Kavet et al. 2016). Although the EMF would exist as long as a cable was in operation, impacts on finfish, invertebrates, and EFH would likely be biologically insignificant.

Light: Light can attract finfish and invertebrates, potentially affecting distributions in a highly localized area. Light can also disrupt natural cycles, e.g., spawning. Offshore wind development would result in additional light from vessels and from offshore structures. Downward-directed deck lighting would have a much greater affect than the navigational lights required on vessels or structures. Construction vessels would be lit during construction, maintenance, and decommissioning and would follow BOEM guidelines for lighting. The impact would likely be small relative to non-wind industry activities. There may or may not be nighttime construction, when lighting impacts would be most acute; in a maximum-case scenario, lights could be active 24 hours per day during construction. This could attract finfish and invertebrates to construction zones, potentially exposing them to greater harm from other IPFs (e.g., noise).

Up to 2,021 WTGs and 45 ESPs would have navigation and/or aviation hazard lights during operation (in accordance with BOEM's lighting and marking guidelines), and these would be incrementally added over the next 10 years and beyond. This would increase the amount of light on the OCS. Because navigation and/or aviation hazard lights are not downward-focused lighting, the amount of such light penetrating the sea surface is anticipated to be minimal and not likely to cause impacts on finfish, invertebrates, and EFH.

New cable emplacement/maintenance: Cable emplacement/maintenance activities could disturb, displace, and injure finfish and invertebrates and result in temporary turbidity and short-term to long-term habitat alterations. The intensity of impacts would depend on the time (season) and place (habitat type) where the activities occur. This IPF causes impacts during construction and maintenance (see also the sediment deposition and burial IPF). Assuming future projects use installation procedures similar to those proposed in the proposed Project COP (Volume I; Epsilon 2020a), the extent of impacts would be limited to approximately 6 feet (2 meters) to either side of each cable, and finfish, invertebrates, and most EFH would recover following disturbance, although some habitats would not fully return to their previous conditions (Hemery 2020). The cable routes for future projects are under discussion but have not been fully determined at this time. The Vineyard Wind 2 Project cable is anticipated to be in close proximity to the proposed OECC. Cables for other future offshore wind projects that would be emplaced within the geographic analysis area are anticipated to occur over the next 10 years and beyond. Using the assumptions in Appendix A, the total area of seafloor disturbed by cable emplacement for offshore wind facilities is estimated to be up to 8,153 acres (33.0 km^2). The geographic analysis area for finfish, invertebrates, and EFH contains over 16 million acres (64,750 km^2) of gravel or hard bottom, over 46 million acres (186,155 km^2) of sand bottom, and over 15 million acres (60,703 km^2) of silt/mud bottom, according to an internal analysis of habitat model data from The Nature Conservancy (2014). The affected area for any one of those sediment types would be less than 0.1 percent of the total area of that type. Short-term effects on populations could occur in the immediate vicinity of installation activities. Turbidity would be increased during construction for 1 to 6 hours at a time. Cable routes that intersect HAPCs, including but not limited to eelgrass and hard-bottom habitats, may cause impacts that may be long-term to permanent; otherwise, impacts of habitat disturbance and mortality from physical contact would be recovered in the short term. Any dredging necessary prior to cable installation could also contribute additional impacts of the type discussed above (see also the sediment deposition and burial and seabed profile alterations IPFs).

Noise: Noise from construction, pile driving, G&G survey activities, aircraft, trenching, operations and maintenance, and vessels could contribute to impacts on finfish, invertebrates, and EFH. The noise having the greatest impact is expected to come from pile driving.

In the expanded planned action scenario, construction of 2,066 offshore structures would create noise that affects finfish, invertebrates, and EFH. The greatest impact of noise is likely to be caused by pile driving. Noise from pile driving would be temporary, occurring during installation of foundations for offshore structures. This noise would be produced intermittently during construction of each project for approximately 2 to 3 hours per foundation or for 4 to 6 hours per day for the installation of two foundations per day. 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 (Figure A.7-4) would likely occur over a 6- to 10-year period. Noise transmitted through water and/or through the seabed can cause injury and/or mortality to finfish and invertebrates in a limited space around each pile and can cause short-term stress and behavioral changes to individuals over a greater space. The extent depends on pile size, hammer energy, and local acoustic conditions; based on estimates from the COP (Volume I, Section 4.2.3.4, Epsilon 2020a; Pyć et al. 2018), behavioral effects from pile-driving noise would likely extend radially less than 5.7 miles (9.2 kilometers) around each pile, the radius for injury is estimated to extend up to 2,618 feet (798 meters), and the radius for potential mortality is estimated to extend 256 feet (78 meters) from each pile, given the proposed noise attenuation mitigation measures (Table 3.3-2). Therefore, the radius for potential injury or mortality would not overlap between any two foundations; the radius for behavioral effects could overlap among two or more foundations if multiple piles are driven simultaneously by one project or multiple projects. If all 2,066 foundations in the expanded planned action scenario are summed, the risk of mortality is expected to occur over approximately 9,758 acres (39.5 km^2). Potentially injurious noise could also be considered as rendering EFH temporarily unavailable or unsuitable for the duration of the noise. The affected areas of seafloor would likely be recolonized in the short term, whereas the water around the foundation would cease to be affected immediately after the noise ceases. Eggs, embryos, and larvae of finfish and invertebrates could also experience developmental abnormalities or mortality resulting from this noise, although thresholds of exposure have not been defined as they have for adult finfish (Weilgart 2018; Hawkins and Popper 2017). The impact of pile-driving noise on finfish and invertebrates would depend on the time of year it occurs; the impact could be greater if the noise occurs in spawning habitat during a spawning period, particularly for those species that aggregate to spawn (e.g., Atlantic cod), use sound to communicate (e.g., Atlantic cod), or spawn only once during their lifetime (e.g., longfin squid). It is anticipated that most pile-driving activity would occur in the summer months when weather windows are favorable. Thus, species that spawn in the summer (e.g., longfin squid, bluefish [*Pomatomus saltatrix*]) would be more susceptible to disturbance from pile-driving noise.

Reduced reproductive success in one or more spawning seasons could result, which could potentially result in long-term effects to populations if one or more cohorts suffer suppressed recruitment. Recent studies on the behavioral impacts of pile-driving noise on black sea bass and longfin squid have shown behavioral responses, but behavior returns to a pre-exposure state after the cessation of the noise (Jones et al. 2020; Shelledy et al. 2018). In the expanded planned action scenario, noise from pile driving could affect the same populations or individuals multiple times in 1 year or in sequential years; it is currently unknown whether it would have less impact to drive many piles sequentially or concurrently.

Noise from G&G surveys of cable routes and other site characterization surveys for offshore wind facilities could also affect finfish and invertebrates. G&G noise would occur intermittently over an assumed 2- to 10-year construction period (Table A-6). It is important to note that 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 airgun 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 needed for only shallow seabed penetration. These activities can disturb finfish and invertebrates in the investigation's immediate vicinity and can cause temporary behavioral changes. Seismic surveys are not expected in the geographic analysis area for finfish, invertebrates, and EFH.

Noise from aircraft, trenching/cable burial, vessels, and WTG operations and maintenance are expected to occur, but would have little effect on finfish, invertebrates, and EFH. Offshore wind projects may use aircraft for crew transport during maintenance and/or construction; however, very little of the aircraft noise propagates through the water, and therefore there is not likely to be any impact of aircraft noise on finfish, invertebrates, and EFH. Noise from trenching of inter-array and export cables would be temporary, local, and extend only a short distance beyond the emplacement corridor. Impacts of trenching/cable burial noise are typically less prominent than the impacts of the physical disturbances discussed under new cable emplacement/maintenance and sediment deposition and burial. Future offshore wind activities would also increase vessel noise. Analysis of vessel noise related to the Cape Wind Energy Project found that noise levels from construction vessels at 10 feet (3 meters) were loud enough to induce avoidance, but not physically harm, finfish and/or invertebrates (MMS 2009). Behavioral impacts would likely be temporary. Finally, 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 adversely affect finfish, invertebrates, and EFH (English et al. 2017). As measured at the Block Island Wind Farm, the low-frequency noise from WTG operation barely exceeds ambient levels at 164 feet (50 meters) from the WTG base. Based on the results of Thomsen et al. (2015) and Kraus et al. (2016), sound pressure levels (SPLs) would be expected to be at or below ambient levels at relatively short distances from WTG foundations (about 164 feet [35.4 meters]). This type of noise would persist for the life of each offshore wind energy project.

Port utilization: It is likely that ports would be upgraded along the East Coast, increasing the total amount of disturbed habitat. Ports are largely privately owned or managed businesses that are expected to compete against each other for offshore wind business. The ports of New Bedford, Hampton Roads, Atlantic City, Ocean City, and Montauk have been identified as possible ports to support offshore wind energy construction and/or operations, and smaller ports could also be upgraded and used for operation and maintenance support. For example, in Vineyard Haven, barrier beach and intertidal habitat would be affected by foreseeable port upgrades, potentially converting these important fish habitats to developed structure. Increases in port utilization due to offshore wind projects would lead to increased vessel traffic. Port expansions would likely happen over the next 6 to 10 years, and the increase in port utilization would be at its peak during construction activities and would decrease during operations but would increase again during decommissioning. In addition, any related port expansion and construction activities related to offshore wind projects would add to the total amount of disturbed habitat. Existing ports have already affected finfish, invertebrates, and EFH by temporarily displacing finfish and invertebrates and disturbing habitats, as well as permanently converting habitats; future port expansions would implement BMPs (e.g., stormwater management, turbidity curtains, Table A-5) to minimize impacts. Although the degree of impacts on EFH would likely be undetectable outside the immediate vicinity of the ports, impacts on EFH for certain species and/or life stages may lead to temporary to permanent impacts on finfish and invertebrates beyond the vicinity of the ports.

Presence of structures: The presence of structures can lead to impacts on finfish, invertebrates, and EFH through entanglement and gear loss/damage, hydrodynamic disturbance, fish aggregation, habitat conversion, and migration disturbances. These impacts may arise from buoys, met towers, foundations, scour/cable protection, and transmission cable infrastructure. The potential locations of cable protection for future projects have not been fully determined at this time. Using the assumptions in Table A-4 in Appendix A, the expanded planned action scenario would include up to 2,066 foundations, 1,723 acres (7.0 km^2) of foundation scour protection, and 1,221 acres (4.9 km^2) of new hard protection atop cables. Projects may also install more buoys and met towers. BOEM anticipates that structures would be added intermittently over an assumed 6- to 10-year period (Table A-6) and that they would remain until decommissioning of each facility is complete. This would be a substantial increase in structure, which is presently rare throughout the geographic analysis area for finfish, invertebrates, and EFH.

The presence of structures may increase private and for-hire recreational fishing effort in areas where there was not effort previously and increase the risk of gear loss/damage by entanglement with structure, potentially leading to injury or mortality of finfish and invertebrates that may become entangled in the lost gear. Commercial fisheries operating near structure may also experience gear loss, potentially increasing the impacts of ghost fishing and other disturbances on finfish, invertebrates, and EFH. Lost commercial fishing gear moved by currents can disturb habitats and potentially harm individuals. Such impacts at any one location would likely be short-term and localized, although the increased risk of occurrence would persist as long as the structures remain.

Manmade structures, especially tall vertical structures such as foundations, alter local water flow at a fine scale. A modeling study by Chen et al. (2016) found that WTG foundations in the southern New England region would not have a significant influence on southward larval transport during storm events, although foundation placement could either increase or decrease larval dispersion and speed, depending on initial location; however, the models never found the foundations to trap or block larval transport. Tank and modeling tests, such as those conducted by Miles et al. (2017) and Cazenave et al. (2016), conclude that mean flows are reduced/disrupted immediately downstream of a monopile foundation, but return to background levels within a distance proportional to the pile diameter (D). These results indicate disruptions for a horizontal distance anywhere between 3.5 D to 50 D, depending on whether it is a current only regime or a wave and current regime, and a width of 65.6 to 164 feet (20 to 50 meters). Thus, for foundations like those proposed by Vineyard Wind, background conditions would be expected between 164 to 1,148 feet (50 to 350 meters) downstream from each monopile foundation. Cazenave et al. (2016) also conducted a shelf-scale modeling exercise on the Irish Sea, home to Walney (+extensions) and West of Duddon Sands, contiguous offshore wind facilities that together contain 297 turbines (with 1.4 GW total power-generation capacity). The shelf-scale model of the eastern Irish Sea indicated a 5 percent reduction in peak water velocities, and found that this reduction may extend up to approximately 0.5 nautical mile (1 kilometer) downstream of a monopile foundation and that impacts varied based on array geometry. In general, modeling studies indicate that water flow typically returns to within 5 percent of background levels within a relatively short distance from the structure (e.g., within 3.5 to 10 times the structure's diameter) (Chen et al. 2016; Miles et al. 2017). Given this, the disruption to mean flows is not likely to reach from one foundation to an adjacent foundation.

Altered hydrodynamics can increase seabed scour and sediment suspension around foundations, resulting in sediment plumes. Sediment plumes around foundations, seen in shallow-water and high-current velocity systems, are not expected in current leased areas on the U.S. OCS. U.S. wind lease areas are generally deeper, where hydrodynamics are less impacted by tidal forcing. The water depth of BOEM's current active offshore wind leases typically range from 59 to 197 feet (18 to 60 meters), whereas the early projects in the North Sea were between 9.8 and 65.6 feet (3 and 20 meters) of water depth. While the surface currents in the U.S. wind lease areas are comparable to those at European wind developments, the bottom currents are typically less, due to the greater water depth. Lower bottom currents lead to a reduction in the potential for scour, the time sediments remain suspended within the water column, and the distance suspended sediments travel. Scour protection measures, such as rock at the base of the foundations, further reduce sediment resuspension due to scour. Thus, effects on finfish, invertebrates, and EFH from sediment resuspension near foundations are not anticipated to be measurable above existing natural/baseline conditions.

The changes in fluid flow caused by the presence of many structures on the OCS could also influence finfish, invertebrates, and EFH at a broader spatial scale. The existing physical oceanographic conditions in the geographic analysis area for finfish, invertebrates, and EFH, with a particular focus on the southern New England region, are described in Appendix E. The spatial scale of the potential effects of many structures on oceanographic conditions is not well known, but may be on the order of 0.5 nautical mile from each structure (Appendix E, Section E.4.5). Although waters on the OCS experience considerable vertical mixing in fall, winter, and spring, an important seasonal feature influencing finfish and invertebrates is the cold pool, a mass of cold bottom water in the mid-Atlantic bight overlain and surrounded by warmer water. The cold pool forms in late spring and persists through summer, gradually moving southwest, shrinking, and warming due to vertical mixing and other factors (Chen et al. 2018). During summer, local upwelling and local mixing of the cold pool with surface waters provides a source of nutrients, influencing the ecosystem's primary productivity, which in turn influences finfish and invertebrates (Lentz 2017; Matte and Waldhauer 1984). The cold pool is a dynamic feature of the middle to outer portions of the continental shelf, but its nearshore boundary typically lies at depths from 66 to 131 feet (20 to 40 meters) (Brown et al. 2015; Chen et al. 2018; Lentz 2017). Offshore wind lease areas are mostly sited within depths less than 197 feet (60 meters). While offshore wind foundation structures would affect local mixing of cool bottom waters with warm surface waters, the extent to which these local effects may cumulatively affect the cold pool as a whole is not well understood. Given the size of the cold pool, approximately 11,580 square miles (30,000 km^2 [NOAA 2020c]), BOEM does not anticipate that future offshore wind structures as described in the expanded planned action scenario would negatively affect the cold pool, although they could affect local conditions. The presence of many wind turbine structures could affect local oceanographic and atmospheric conditions by reducing wind-forced mixing of surface waters and increasing vertical mixing of water forced by currents flowing around foundations (Carpenter et al. 2016; Cazenave et al. 2016; Schultze et al. 2020). During times of stratification (summer), increased mixing could possibly increase pelagic primary productivity in local areas, possibly resulting in increased biomass of finfish and invertebrates. Changes in primary productivity might not translate into effects on finfish and commercially important invertebrates if the increased productivity is consumed by filter feeders such as mussels that colonize the structure surfaces (Slavik et al. 2019). Increased mixing may also result in warmer bottom temperatures. Warmer bottom temperatures may increase stress on some shellfish and fish that are at the southern/inshore extent of their temperature tolerance. The ultimate impacts on finfish and invertebrates of changes to local oceanographic and atmospheric conditions caused by the presence of offshore structures are expected to be localized, and likely to vary seasonally and regionally.

Structures, including tower foundations, scour protection around foundations, and various means of hard protection atop cables would create uncommon vertical relief in a mostly sandy seascape. Structure-oriented fishes (e.g., black sea bass, striped bass [*Morone saxatilis*], Atlantic cod) would be attracted to these locations. Abundance of certain fishes may increase (Claisse et al. 2014; Smith et al. 2016) near the structures. These impacts would be local and likely permanent as long as the structures remain. The effects of fish aggregating around structures may be considered adverse, beneficial, or neutral to finfish and invertebrate populations, as the dynamics of predation and fishing would vary by location.

In addition to fish aggregation, the new structure may also provide new hard-structure habitat for structure-oriented and/or hard-bottom species, which may benefit (Daigle 2011). Cable protection, scour protection, and foundations would convert habitat from a soft-bottom to hard-structure habitat, although it would differ from the typical hard-bottom habitat in the geographic analysis area for finfish, invertebrates, and EFH, namely, coarse substrates in a sand matrix. This would constitute a modification of the existing soft-bottom or hard-bottom habitat, and it may or may not function similarly to hard-bottom habitat typical in the region (Kerckhof et al. 2019; HDR 2019). Soft bottom is the dominant habitat type from Cape Hatteras to the Gulf of Maine (over 60 million acres [242,811 km^2]), and species that rely on this habitat would not likely experience population-level impacts (Guida et al. 2017; Greene et al. 2010). The new surfaces could also be colonized by invasive species (e.g., certain tunicate species) found in hard-bottom habitats on Georges Bank (Frady and Mecray 2004). The new structures could create an artificial reef effect, attracting a different community of fish and invertebrates in the immediate vicinity of the structures. Species preferring hard-bottom habitat (e.g., Atlantic cod, American lobster, black sea bass, striped bass, etc.) would gain habitat while obligate soft-bottom species (e.g., summer flounder, Atlantic surfclam [*Spisula solidissima*], longfin squid) would see habitat locally reduced. The attraction of structure-oriented predators (e.g., black sea bass) may affect prey species, including lobster. The reef effect has been observed around WTGs, leading to local increases in biomass and diversity (Causon and Gill 2018); however, the diversity may decline over time as early colonizers are replaced by successional communities dominated by blue mussels (*Mytilus edulis*) and anemones (Kerckhof et al. 2019). Invertebrate and fish assemblages may develop around these reef-like elements within the first year or two after construction (English et al. 2017). Although some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the reef effect results in increased productivity versus simply attracting and aggregating fish from the surrounding areas (Causon and Gill 2018). Recent observations at the Block Island Wind Farm have reported considerable colonization by mussels (ten Brink and Dalton 2018; HDR 2019). The potential effects of offshore wind facilities on offshore ecosystem functioning has been studied using simulations calibrated with field observations (Raoux et al. 2017; Pezy et al. 2018; Wang et al. 2019). These studies indicated that the offshore wind facilities can increase bivalve biomass and shift local food webs toward a greater amount of detritivory.[2] They also indicated higher biomass for benthic fish and invertebrates and possibly for pelagic fish, marine mammals, and birds as well. Overall, omnivory,[3] energy recycling, and general ecosystem activity were all predicted to increase after offshore wind facility construction (Raoux et al. 2017; Pezy et al. 2018; Wang et al. 2019). These changes may not necessarily happen evenly across an entire offshore wind facility, but are likely concentrated around the vicinity of each structure. Various attempts to measure the linear extent of the reef effect have reported distances from 52.5 feet (16 meters) (Stanley 1994) to 1,968.5 feet (600 meters) (Kang et al. 2011) from a structure, and Rosemond et al. (2018) have suggested assuming a distance of 98 to 197 feet (30 to 60 meters) as a first approximation. These studies indicate that offshore wind facilities can generate beneficial impacts on local ecosystems. The presence of many distinct hard structure areas could also increase connectivity between geographically distant populations (Folpp et al. 2011; Mora et al. 2003), as the structures may provide patches of attractive habitat, helping structure-oriented species traverse the mostly sandy OCS.

Future offshore wind structures would lie in the paths of some migratory species, including finfish and invertebrates that exhibit onshore/offshore seasonal migrations (e.g., summer flounder, longfin squid, monkfish [*Lophius* spp.], black sea bass, and lobster). There is little empirical information available to indicate what effect, if any, structures might have on movement patterns and migrations (Sparling et al. 2020). Structures can attract finfish and invertebrates that approach the structures during their migrations. This could tend to slow migration if migrating individuals choose to find food or shelter at the structure instead of proceeding at their typical pace of travel. However, temperature is expected to be a bigger driver of habitat occupation and migration than structure would be (Moser and Shepherd 2009; Fabrizio et al. 2014; Secor et al. 2018). Migratory animals would likely be able to proceed from structures unimpeded.

[2] The state of being a detritivore, i.e., a detritivore is an organism that obtains its nutrition by feeding on detritus.

[3] The state of being omnivorous, i.e., an omnivorous animal is one that has the ability to eat and survive on both plant and animal matter.

In addition to these studies, some countries like Belgium and Denmark have funded long-term monitoring programs (Bergström et al. 2014; Kerckhof et al. 2019; Lefaible et al. 2019). These studies broadly show that long-term operational impacts on the marine benthic environment (e.g., increased animal abundances, compositional shifts) are evident close to foundations and scour protection (Lefaible et al. 2019), and no impacts have been evident at the scale of an entire facility (Bergström et al. 2014). In Belgium, monitoring conducted at wind facilities between 2005 and 2016 found the number of epibenthic and demersal-benthopelagic fish species remained similar over the years and was not affected by the construction of the wind facilities (Degraer et al. 2018). Epibenthic density and biomass showed a similar trend with an increase in the first 2 years after construction. These higher values, however, levelled off 3 years after construction. As for epibenthos, demersal-benthopelagic fish seemed to show more variance in densities only in the first few years after construction. These results indicate that the soft-sediment ecosystem in between the turbines (at distances greater 656 feet [200 meters]) has not changed substantially 5 to 6 years after construction and that species assemblages within the offshore wind energy facilities seem to be mainly structured by temporal variability at larger spatial scales (e.g., temperature fluctuations, hydrodynamic changes, plankton blooms). Similar to studies in other parts of the North Sea, there were some species of fish that seemed to respond positively to the offshore wind facility, but these potentially beneficial effects cannot be untangled from the reduction in fishing effort within the wind facility. With the exception of the United Kingdom, European countries have prohibited mobile trawl fishing within offshore wind facilities.

Considering the above information, BOEM anticipates that the impacts of the presence of structures on finfish, invertebrates, and EFH may be neutral to beneficial. These impacts would be permanent as long as the structures remain.

Regulated fishing effort: While primarily an ongoing activity, regulated fishing effort impacts finfish, invertebrates, and EFH by modifying the nature, distribution, and intensity of fishing-related impacts (mortality, bottom disturbance). Regulated fishing effort results in the removal of a substantial amount of the annually produced biomass of commercially regulated finfish and invertebrates and can also influence bycatch of non-regulated species. Future offshore wind development other than the proposed Project could influence finfish, invertebrates, and EFH through this IPF by influencing the management measures chosen to support fisheries management goals, which may alter the nature, distribution, and intensity of fishing-related impacts on finfish, invertebrates, and EFH. Section 3.10.1 provides details.

Seabed profile alterations: Dredging used in the course of cable installation can cause localized, short-term impacts (habitat alteration, change in complexity) on finfish, invertebrates, and EFH through seabed profile alterations, as well as through sediment deposition. The level of impact from seabed profile alterations could depend on the time of year that they occur, particularly in nearshore locations, especially if they overlap with times and places of high finfish and invertebrate abundance or sensitive life stages. Locations, amounts, and timing of dredging for future 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, such impacts from future offshore wind activities other than the proposed Project would likely be on the order of 20 times more than the proposed Project alone. Dredging is most likely in sand wave areas where typical jet plowing is insufficient to meet target cable burial depth. Sand waves that are dredged would likely be redeposited in like sediment areas. Any particular sand wave may not recover to the same height and width as pre-disturbance. However, the habitat function would largely recover post-disturbance, although full recovery of faunal assemblage may require several years (Boyd et al. 2005). Therefore, seabed profile alterations, while locally intense, have little impact on finfish, invertebrates, and EFH on a regional (Cape Hatteras to Gulf of Maine) scale.

Sediment deposition and burial: Dredged material disposal during construction would cause temporary, localized turbidity increases and long-term sedimentation or burial at the immediate disposal site. Cable emplacement/maintenance activities (including dredging) during construction or maintenance of future offshore wind projects could cause sediment suspension for 1 to 6 hours at a time, after which the sediment is deposited on the seafloor. Sediment deposition could have impacts on demersal eggs and larvae, such as longfin squid eggs (which are known to have high rates of mortality if egg masses are exposed to abrasion or burial), winter flounder eggs, and shellfish larvae. Impacts may vary based on season or time of year and location (i.e., habitat type). The cable routes for future projects are under discussion but have not been fully determined at this time. The Vineyard Wind 2 Project cable is anticipated to be in close proximity to the proposed OECC. Cables for other future offshore wind projects that would be emplaced within the geographic analysis area are anticipated to occur over the next 10 years and beyond. Locations, amounts, and timing of dredging for future offshore wind projects are not known at this time. Assuming the areal extent of sediment deposition and burial impacts is proportional to the length of cable installed (Table A-4), such impacts would likely be on the order of 20 times more than the proposed Project (i.e., the proposed Project estimated that it would cause sediment deposition on up to 2,594 acres [10.5 km^2]). 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 impacted areas would only be lightly sedimented (less than 0.04 inch [1 millimeter]) and would recover naturally in the short term.

Climate change: Finfish, invertebrates, and EFH may be affected by climate change, primarily from increasing ocean surface and bottom temperatures, which has been shown to impact the distribution of fish in the northeast United States, with several species shifting their centers of biomass either northward or to deeper waters (Gaichas et al. 2015; Hare et al. 2016). As a result of climate change, the composition of the fish assemblage in any particular location, and the seasonal dynamics of that assemblage, may change, potentially leading to changes in fishing activity. Warming of ocean waters is expected to influence the migrations of finfish and invertebrates and may influence the frequencies of various diseases (Hoegh-Guldberg and Bruno 2010; Brothers et al. 2016). CO_2 emissions also cause ocean acidification, possibly contributing to reduced growth or the decline of invertebrates that have calcareous shells (PMEL 2020). See Section A.8.1 for details on the expected contribution of offshore wind activities to climate change.

Other considerations: The endangered Atlantic sturgeon is the only finfish or invertebrate listed under the ESA that may be affected by the proposed Project. Subadult and adult Atlantic sturgeon occur in marine waters year-round. Ongoing activities, future non-wind activities, and future offshore wind activities other than the proposed Project may also affect the Atlantic sturgeon. Because all five distinct population segments (DPS) of the Atlantic sturgeon could be affected by the proposed Project, the geographic analysis area for this species is its entire range shown on Figure A.7-4. According to the analysis in BOEM's BA for Alternative A (BOEM 2019d), all of the IPFs and impacts on finfish and EFH discussed above could also apply to the Atlantic sturgeon. The most prominent IPF for sturgeon is likely to be noise from pile driving; however, most pile driving is anticipated to occur in the summer, when mature Atlantic sturgeon are more likely to reside in rivers and nearshore waters, thus reducing their risk of exposure to pile-driving noise (Ingram et al. 2019).

3.3.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, finfish, invertebrates, and EFH would continue to follow current regional trends and respond to current and future environmental and societal activities.

While the proposed Project would not be built as proposed under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind activities, and future offshore wind activities to have continuing temporary to permanent impacts (disturbance, displacement, injury, mortality, reduced reproductive success, habitat degradation, habitat conversion) on finfish, invertebrates, and EFH, primarily through resource exploitation/regulated fishing effort, dredging, bottom trawling, bycatch, G&G survey noise, pile-driving noise, new cable emplacement, the presence of structures, and climate change. BOEM anticipates that the impacts of ongoing activities, especially fishing, dredging, and climate change, would be **moderate**. Fisheries monitoring that Vineyard Wind has committed to voluntarily perform, the results of which could provide an understanding of the effects of offshore wind development, benefit future management of finfish, invertebrates, and EFH, and inform planning of other offshore developments. However, other ongoing and future surveys could still provide similar data to support similar goals. In addition to ongoing activities, reasonably foreseeable activities other than offshore wind may also contribute to impacts on finfish, invertebrates, and EFH. Reasonably foreseeable activities other than offshore wind include increasing vessel traffic, new submarine cables and pipelines, increasing onshore construction, marine surveys, marine minerals extraction, port expansion, channel deepening activities, and the installation of new towers, buoys, and piers (Table 3.3-1). BOEM anticipates that the impacts of reasonably foreseeable activities other than offshore wind would be **minor**. BOEM expects the combination of ongoing activities and reasonably foreseeable activities other than offshore wind to result in **moderate** impacts on finfish, invertebrates, and EFH, primarily driven by ongoing fishing activities.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in **moderate** impacts and could potentially include **moderate beneficial** impacts. Future offshore wind activities are expected to contribute considerably to several IPFs, the most prominent being the presence of structures, namely foundations and scour/cable protection. The majority of offshore structures in the geographic analysis area for finfish, invertebrates, and EFH would be attributable to the future offshore wind industry. The future offshore wind industry would also be responsible for the majority of impacts related to new cable emplacement and to pile-driving noise. However, BOEM expects that ongoing impacts resulting from fishing pressure, especially via dredging and bottom-trawling methods, will continue to be one of the most impactful IPFs controlling the condition of finfish and invertebrates in the geographic analysis area for finfish, invertebrates, and EFH.

The No Action Alternative would forgo the fisheries monitoring that Vineyard Wind has voluntarily committed to perform, the results of which could provide an understanding of the effects of offshore wind development; benefit future management of finfish, invertebrates, and EFH; and inform planning of other offshore developments. However, other ongoing and future surveys could still provide similar data to support similar goals.

3.3.2. Consequences of Alternative A

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on fish, invertebrates, and EFH:

- The total amount of long-term habitat alteration from scour protection for the foundations, inter-array cables, and export cables.
- The total amount of habitat temporarily altered by installation of the export cable in the OECC and for inter-array and inter-link cables in the WDA.
- The number and type of foundations used for the WTGs and ESPs. Vineyard Wind could construct a maximum of 100 WTGs and two ESPs using either all monopiles (34 feet [10.3 meters]) or monopiles and up to two jacket piles (four 9.8-foot [3-meter] pins).
- The time of year construction activities occur in relation to migrations and spawning for fish and invertebrate species.
- The level of risk associated with non-routine events.

Impacts from Alternative A alone would include temporary and long-term consequences resulting from habitat alteration, increased turbidity, sediment deposition, entrainment, increased noise, vessel strike, and EMF. Other impacts associated with Alternative A may occur as a consequence of routine activities after Vineyard Wind completes construction, although the impact of routine post-construction activities on fish, invertebrates, and EFH is likely to be **negligible**, based on the small fraction of the habitat within the WDA and OECC that would be affected. The EFH assessment (BOEM 2019e, 2020b) discusses specific impacts on designated EFH. Appendix F, Section F.6, contains further discussion of the NMFS EFH conservation recommendations along with BOEM's response to those conservation recommendations. BOEM intends to adopt most of the EFH conservation recommendations, except for those that are not technically feasible or which, if adopted, would not substantially avoid or mitigate effects to EFH.

Alternative A alone would likely result in impacts (disturbance, displacement, injury, mortality, reduced reproductive success, habitat degradation, habitat conversion) that are expected to be local and to not alter the overall character of finfish, invertebrates, and EFH in the geographic analysis area for finfish, invertebrates, and EFH. The potential impacts would partially depend on which offshore export cable route was chosen, so this analysis assumes the maximum-case scenario. Some impacts would be adverse and some could be beneficial; overall, the impacts of Alternative A alone on finfish, invertebrates, and EFH would likely be **moderate,** including the presence of structure, which may result in **moderate beneficial** impacts.

Alternative A would contribute to impacts through all the IPFs named in Section 3.3.1.1 except for light from vessels and port utilization; Alternative A would not involve changes to port utilization (and Alternative A's use of an already upgraded and operating port facility is not expected to impact finfish, invertebrates, and EFH). The most impactful IPFs would likely include pile-driving noise, which would cause mortality, injury, and behavioral changes for 4 to 6 hours at a time during construction; new cable emplacement, which would cause mortality, injury, turbidity, and short-term to long-term habitat degradation; and the presence of structures, which would lead to a permanent, possibly beneficial, impact by providing new habitat as long as the structures remain. Other IPFs would likely contribute impacts of lesser intensity and extent, and would occur primarily during construction, but also during operations and decommissioning. For details, see Table 3.3-1.

Accidental releases: In addition to accidental releases of other materials, accidental releases of invasive species from vessels associated with Alternative A would have a low risk of resulting in widespread and permanent impacts, as discussed in Section 3.3.1.1. The increase in risk of accidental releases of invasive species attributable to Alternative A would be **negligible**. Section 2.3 describes the non-routine activities associated with the Proposed Action. These activities, if they were to occur, would generally require temporary activity to address emergency conditions, fuel spills, accidental releases of waste material, collisions, and allisions. Non-routine events such as oil or chemical spills can have adverse or lethal effects on marine life. Spills are expected to occur at the surface, and impacts on the water column would be mostly limited to the surface-mixed layer, or approximately 33 feet (10 meters). Oils in particular tend to stay at the surface, and other chemicals are predicted to dilute to non-toxic levels before they would reach most finfish, invertebrates, and EFH. Small spills should therefore have a **negligible** impact while larger spills, which are unlikely, could have a **moderate** impact on species due to negative effects on water quality (Appendix A.8.2).

The **negligible** impact of Alternative A alone would not increase the risk of accidental releases beyond the risk under the No Action Alternative. The risk of impacts on finfish, invertebrates, and EFH due to accidental releases of invasive species could be **major** if the invasive species become(s) established and out-compete(s) native fauna. However, the greatest source of risk comes from ongoing activities, with offshore wind contributing only a small amount of increased vessel traffic from overseas ports. In context of reasonably foreseeable environmental trends, the combined impacts of other types of accidental releases from ongoing and planned actions, including Alternative A, would be highly similar to the impacts under the No Action Alternative and would be **negligible** to **minor**.

Anchoring: Anchoring used in the course of Alternative A would leave marks on the seabed, increase turbidity levels, and have the potential for physical contact to cause mortality of benthic and demersal species. Vineyard Wind's Final Environmental Impact Report (Epsilon 2018c) estimated that anchoring would disturb up to 4.4 acres (17,806 m^2). All impacts would be localized, turbidity would be temporary, and most impacts from physical contact would be recovered in the short term. Degradation of sensitive habitats such as certain types of hard bottom, if it occurs, could be long-term to permanent. Alternative A would not anchor in eelgrass. The anticipated impacts on finfish, invertebrates, and EFH of anchoring under Alternative A alone would be **minor**.

The **minor** impact of anchoring on 4.4 acres (17,806 m^2) in Alternative A alone would not increase the impacts of anchoring beyond the approximately 276 acres (1.1 km^2) of impacts under the No Action Alternative. According to the assumptions stated in Appendix A, the amount of anchoring disturbance in Alternative A does not add to the amount of anchoring disturbance under the No Action Alternative, but rather it preempts an equal amount that might otherwise have occurred at a later time. In context of reasonably foreseeable environmental trends, combined anchoring impacts on finfish, invertebrates, and EFH from ongoing and planned actions, including Alternative A, would likely be **minor**.

BOEM could require Vineyard Wind, as a condition of COP approval, to develop and implement an anchoring plan (Appendix D), 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 to be feasible; therefore, the significance level of anchoring impacts would remain the same.

EMF: Many marine and diadromous species can sense electric and/or magnetic fields, and EMF from power cables may affect their ability to navigate and detect predators/prey, or could cause physiological and developmental effects (Taormina et al. 2018; Gill and Desender 2020). Buried cables reduce, but do not entirely eliminate, EMF (Taormina et al. 2018). During the operations and maintenance phase of Alternative A, powered transmission cables would produce EMF and heat (Taormina et al. 2018). To minimize EMF generated by cables, all cabling would be contained in grounded metallic shielding to prevent detectable electric fields. Vineyard Wind would also bury cables to a target burial depth of 5 to 8 feet (1.5 to 2.5 meters) below the surface or utilize cable protection, which would diminish the effect of EMF so that it would likely impact only demersal species. The closer the cable is to the sediment-water interface, the stronger the exposure to magnetic fields.

Demersal species living on or near the seafloor, where the magnitude of cable EMF would be highest, are more likely to detect EMF than pelagic species, which live higher in the water column. Cable networks like the inter-array cable in the WDA could potentially have collective impacts on finfish and invertebrates that encounter multiple cables on a regular basis as part of their typical movement patterns. However, the minimal distance of EMF radiating from each cable in the WDA (approximately 65.6 feet [20 meters]; Normandeau et al. 2011) and the spacing of the cables (approximately 1 mile [1.6 kilometers] apart) should create a large enough gap between cables to reduce any collective impact from such frequent and repeated encounters.

Atlantic sturgeon have both electro and magneto sensitivity that can affect feeding, predator detection, and navigation (BOEM 2012a), although research suggests marine species may be less likely to detect EMF from AC cables (BOEM 2012a). Although some species-specific avoidance behavior has been observed, no evidence of population-scale impacts or adverse physiological impacts have been reported (Taormina et al. 2018; Gill and Desender 2020). Studies of EMF impacts on invertebrates are scarce (Taormina et al. 2018; Gill and Desender 2020). American lobster held in cages displayed behavioral differences when exposed to EMF, but the research did not indicate a barrier to movement (Hutchison et al. 2018, 2020). The same studies found that little skate, an electrosensitive elasmobranch, was even more sensitive to the EMF, which led to movement patterns that could be interpreted as increased foraging behavior; again, the EMF did not constitute a barrier to movement. Although a study by Scott et al. (2018) found that the crab *Cancer pagurus* is attracted to EMF, the effects were seen only at field strengths greater than 150 times the field strength expected directly over Vineyard Wind's proposed cables (Epsilon 2018d). Currently there is no evidence that EMF would result in population-scale negative impacts on fish or invertebrates (Taormina et al. 2018; Hutchison et al. 2018, 2020; Gill and Desender 2020). A field survey found that an AC cable design comparable to that proposed by Vineyard Wind produced a much weaker magnetic field than expected (Hutchison et al. 2018); field strength was insignificant approximately 33 feet (10 meters) from the cable. Therefore, effects on pelagic species would likely be **negligible**. BOEM anticipates that by burying cables and containing them in grounded metallic shielding (Normandeau et al. 2011) the impacts of EMF should be **minor** on finfish, invertebrates, and EFH. Please see the EFH assessment for additional discussion of EMF impacts on other fish or invertebrates with EFH in the WDA and OECC (BOEM 2019e). NMFS's BO concluded that EMF from the proposed Project would be extremely unlikely to affect the Atlantic sturgeon (NMFS 2020b).

The **negligible** to **minor** impact of Alternative A alone would not increase the impacts of EMF beyond the impacts under the No Action Alternative. In context of reasonably foreseeable environmental trends, combined EMF impacts from ongoing and planned actions, including Alternative A, would be highly similar to the impacts under the No Action Alternative and would be **negligible** to **minor**. As described in Appendix A, EMF from multiple cables would not overlap even for multiple cables within a single OECC.

Light: Alternative A would allow nighttime work only on an as-needed basis (and would not allow pile driving to begin at night), in which case the Project would reduce lighting of vessels, so light from vessels is not anticipated to result in biologically meaningful impacts on finfish, invertebrates, and EFH. Up to 100 turbines and two ESPs would bear aviation hazard navigation lights, but no downward-focused lighting. Only a small fraction of the emitted light would enter the water. Therefore, light resulting from Alternative A would be minimal and would be expected to lead to a **negligible** impact, if any, on finfish, invertebrates, and EFH.

The **negligible** impact of Alternative A alone would not noticeably increase the impacts of light beyond the impacts under the No Action Alternative. In context of reasonably foreseeable environmental trends, combined light impacts from ongoing and planned actions, including Alternative A, would be highly similar to the impacts under the No Action Alternative and would be **negligible**, mostly attributable to ongoing activities.

New cable emplacement/maintenance: Cable installation impacts would include temporary displacement of mobile benthic species inhabiting the OECC route (i.e., winter flounder, American lobster, monkfish). Impacts on sessile species and life stages (i.e., demersal eggs, squid egg mops, Atlantic surfclam) would include a reduction in fitness or mortality. Impacts related to habitat disturbance in the immediate area of construction activities would be unavoidable and temporary to permanent, depending on the type of habitat affected. Localized loss of demersal eggs could lead to reduced fish recruitment; however, this would be limited and BOEM does not anticipate impacts at a population level. For the Cape Wind project, seabed scars associated with jet-plow cable installation were expected to recover in 1 to 38 days, according to modeling by Applied Science Associates (2005), allowing for rapid recolonization from the surrounding area (MMS 2009). The proposed Project would not affect beds or loose aggregations of eelgrass EFH HAPC for juvenile and adult summer flounder because the proposed Project would avoid eelgrass aggregations, but it could affect HAPC for juvenile Atlantic cod. All of the hard-bottom habitat within the proposed Project OECC would be considered HAPC for juvenile Atlantic cod, as would some other habitat types not mapped. Some HAPC for juvenile Atlantic cod in the OECC would be altered by cable installation. The total amount of juvenile Atlantic cod HAPC that could be disturbed by the proposed Project is not known, but would not exceed the total area of disturbance within the OECC, namely 186 acres (0.75 km^2) (Table 3.2-2).

To avoid impacts on the high concentrations of fishing activities and natural resource events (e.g., spawning of squid and other species) in springtime within Nantucket Sound, Vineyard Wind has agreed to avoid cable installation in Nantucket Sound during springtime. Overall, BOEM expects **moderate** impacts from the temporary habitat disturbance that would not be expected to affect the viability of finfish and invertebrate populations.

Although applicable to both construction and operations, Vineyard has committed to a fisheries monitoring plan. Fisheries monitoring would be conducted before, during, and after construction in the Project area and control areas to support a "beyond Before After Control Impact" analysis (e.g., sampling at multiple control sites at multiple periods before and after impact). Sampling would be conducted four times: pre-construction (to assess baseline conditions); during construction; and at two different intervals during operation (i.e., 1 year after construction and in some later year post-construction). Each of these four assessment periods would capture all four seasons of the year. Fisheries survey methodologies include: trawl survey for finfish and squid; ventless trap survey; plankton survey; and optical survey (drop-camera) of benthic invertebrates and habitats. All fisheries monitoring plan surveys would be consulted and coordinated among BOEM, NMFS, and Vineyard Wind to ensure that effects from post-construction monitoring activities are mitigated to the level of least practicable adverse impact.

The benthic monitoring plan is detailed in Section 3.2 and would document the disturbance to and recovery of marine benthic habitat and communities as a result of construction and installation of different Project components. Post-construction monitoring could reduce later impacts on finfish and invertebrate resources in the region. Information gained via post-construction monitoring by Vineyard Wind could be used to inform Vineyard Wind's decommissioning procedures and/or could be used by others planning similar projects in the future to assist in reducing potential impacts.

COP Appendix A models the potential turbidity resulting from construction activities (Volume III; Epsilon 2020b). The extent and degree of changes in turbidity are discussed in Section A.8.2. Impacts associated with turbidity are likely to affect benthic species more than pelagic species, because the increased turbidity occurs primarily in the bottom 9.8 feet (3 meters) of the water column (COP Volume III, Appendix III-A; Epsilon 2020b). Turbidity would likely displace mobile juvenile and adult species (i.e., striped bass, alewife), which could expose them to increased predation, temporarily reduce prey availability, and result in higher energetic costs. For sessile organisms unable to escape the suspended sediment plumes, the impacts could range from mortality to reduced fitness (Wilber and Clarke 2001; Berry et al. 2011). Sub-lethal effects for mollusk eggs occur with an exposure of 200 mg/L for 12 hours; for other life stages, the minimum threshold for sub-lethal effects took 24 hours at 100 mg/L (COP Volume III, Section 6.5.2.1.3; Epsilon 2020b). Sessile organisms in the WDA might be affected by turbidity multiple times during the construction process, potentially compounding effects and possibly increasing mortality. Based on the modeled concentration of total suspended solids (TSS) and the estimated time it would remain suspended, BOEM expects **minor** temporary impacts, as any reductions in abundance or fitness of organisms would likely recover naturally. Please refer to the EFH assessment and BOEM (2018b, 2019e, 2020e) for additional information on potential impacts on fish, invertebrates, and EFH for proposed-Project activities (Section 5.1.2 in BOEM 2019e; Section 5.3.1 in BOEM 2019d).

Water withdrawals are necessary for jet-plow cable installation, one of the primary methods of installing the export cable in the OECC as well as the WDA inter-array and inter-link cables. See COP Section 6.5.2.1.3 for a description of water withdrawal and estimates of quantities (Volume III; Epsilon 2020b). Due to the surface-oriented intake for the jet plow, water withdrawal could entrain eggs and larvae of pelagic finfish and invertebrates, resulting in 100 percent mortality (MMS 2009). However, the rate of egg and larval survival to adulthood for many species of marine finfish is very low (MMS 2009), and mortality associated with entrainment would be insignificant. Jet plowing would impact species with pelagic eggs or larvae, including numerous flatfish species (e.g., windowpane flounder, winter flounder, witch flounder [*Glyptocephalus cynoglossus*], yellowtail flounder, and summer flounder), important commercial groundfish species (e.g., Atlantic cod, haddock, pollock), and other recreationally and commercially important species (e.g., monkfish, Atlantic herring, Atlantic mackerel [*Scomber scombrus*], silver hake, butterfish). Species with demersal eggs (e.g., longfin squid, Atlantic sea scallops, Atlantic wolffish, ocean pout [*Zoarces americanus*], winter flounder), which adhere to bottom substrate, would not be affected by the water withdrawal aspect of jet plowing. Most jet plowing would take place during summer and could impact eggs and larvae present at that time. See EFH assessment for species with EFH for pelagic eggs (Section 4 in BOEM 2019e). Based on the limited time of jetting and the overall habitat available for pelagic eggs and larvae in comparison to the volume of water withdrawn, BOEM expects **minor** temporary impacts, with affected populations completely recovering after jet plowing activities. Please refer to the EFH assessment, BA, and BO for additional information on potential impacts on fish, invertebrates, and EFH for proposed-Project activities (Section 5.1.2 in BOEM 2019e; Section 5.3.1 in BOEM 2019d; Section 7.3 in NMFS 2020b).

BOEM expects **negligible** impact on finfish, invertebrates, and EFH at the landfall site because the HDD would traverse under the seafloor and beach at Covell's Beach. Vineyard Wind expects construction at the landfall site and installation of the OECC to begin in the second quarter of 2022. Due to summer construction restrictions on Cape Cod (unless authorized by the Town of Barnstable), Vineyard Wind would not make the landfall transition from June through September.

Alternative A's **moderate** incremental impact of up to 328 acres (1.3 km^2) of seafloor disturbed by cable installation and up to 69 acres (0.3 km^2) affected by dredging prior to cable installation would not increase the total impact(s) of all cable installation activities, including offshore wind activities, that occur within the geographic analysis area for finfish, invertebrates, and EFH because, according to the assumptions stated in Appendix A, the amount of new cable in Alternative A does not add to the amount of new cable under the No Action Alternative, but rather it preempts an equal amount that might otherwise have occurred at a later time. 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 (Appendix H in MMS 2009); however, impact duration and intensity may differ across habitat types. Suspended sediment concentrations during activities other than dredging would be within the range of natural variability for this location. In context of reasonably foreseeable environmental trends, the combined impacts of this IPF on finfish, invertebrates, and EFH from ongoing and planned actions, including Alternative A, would likely be **moderate**. Any dredging necessary prior to cable installation could also contribute additional impacts.

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredging and cable installation methods and timing (Appendix D), potentially in combination with additional habitat characterization. This would reduce the degree of new cable emplacement impacts compared to the maximum-case scenario, although the impacts described above would still occur; therefore, the significance level of impacts would remain the same.

Section 2.3 describes the non-routine activities associated with Alternative A; similar non-routine activities could occur for other future offshore wind activities. These activities, if they were to occur, would generally require temporary activity to address emergency conditions. Impacts from occasional non-routine activities to repair segments of cables would be similar to those temporary habitat disturbances involved in installation. Generally, the disturbance to finfish, invertebrates, and EFH would be temporary and localized, with an abundance of similar foraging habitat and prey available in adjacent areas.

Noise: Noise from G&G surveys may occur during Alternative A. G&G noise can disturb finfish and invertebrates in the immediate vicinity of the survey and can cause temporary behavioral changes. Impacts on finfish, invertebrates, and EFH of G&G noise from Alternative A alone are anticipated to be **negligible**.

Pyć et al. (2018) modeled the potential noise exposure from pile driving in the WDA on finfish and invertebrates (COP Section 6.6.2.1.2, Volume III; Epsilon 2020b). The PDE includes the use of impact hammers with up to 4,000 kilojoule (kJ) energy ratings. Estimated pile-driving schedules, meaning the number of strikes per energy level, were supplied by Vineyard Wind. The highest energy level necessary for pile driving at the proposed Project is estimated to be 2,500 kJ (COP Volume I, Section 4.2.3.4, Epsilon 2020a; Pyć et al. 2018). As such, radial distances to sound threshold criteria were modeled using 2,500 kJ hammer energy (Table 3.3-2). If greater hammer power were required to penetrate resistant layers of substrate, the increase in power would be temporary, and the average daily pile-driving noise would not be expected to exceed that shown in Table 3.3-2.Vineyard Wind would utilize a soft-start approach, in which the initial hammer blows occur at reduced energy levels, allowing time for mobile animals to leave the affected area before hammer energy is gradually increased to the full 2,500 kJ. The thresholds used to assess the potential for physiological injury for large (> 2 grams) and small (< 2 grams) fish were 12-hour cumulative sound exposure levels of 187 and 183 dB re 1 micropascal squared second (μPa^{2}s), respectively (Stadler and Woodbury 2009). The threshold used to gauge behavioral disruption was a peak SPL of 150 dB re 1 μPa (decibels relative to 1 micropascal) (Stadler and Woodbury 2009) (Table 3.3-2). Based on acoustic modeling conducted by Vineyard Wind, the radial distance at which physiological injury occurs from pile driving a 34-foot-diameter (10.3-meter) foundation in 24 hours with 6 dB of attenuation (Pyć et al. 2018) is greater for small fish (4.6 to 5.63 miles [7,400 to 9,075 meters]) than for large fish (3.6 to 4.3 miles [5,714 to 6,894 meters]) (Table 3.3-2). Potential impacts of pile driving noise on Atlantic sturgeon, a large fish, are discussed in Section 5.3.1.2 of BOEM (2018b). Although Vineyard Wind has proposed to achieve 12 dB attenuation, this EIS assesses impacts under an attenuation level of only 6 dB as a maximum-case scenario. The range for behavioral responses to pile-driving noise is the same for small and large fish (4.7 to 5.7 miles [7,598 to 9,229 meters]).

Noise impacts on fish and invertebrates in the WDA and OECC would vary depending on the method of sound detection used by the animal. Fish and invertebrates are likely more sensitive to particle motion rather than to SPLs. Unfortunately, standards for measuring and modeling particle motion are still a developing field of research (Hawkins and Popper 2017). Furthermore, there are no agreed upon thresholds for injury or behavioral effects for fish and invertebrates based on particle motion as there are for SPLs (NMFS 2016). Thus for the purposes of this assessment, BOEM is using standards and thresholds for SPLs.

Fish with a gas chamber involved in hearing (e.g., Atlantic herring and gadids) are the most susceptible while those without swim bladders (e.g., sharks, rays, flatfish) are the least susceptible (Popper et al. 2014). Research shows that noise can damage the sensory organs responsible for equilibrium and motility in squid species (Solé et al. 2013). The EFH assessment (Table 2 in BOEM 2019e) uses three hearing sensitivity categories as discussed by Popper et al. (2014) for finfish, and classifies invertebrates as fish without swim bladders. Pile driving would occur from July through December 2020 (COP Section 4.1, Volume I; Epsilon 2020a). Noise generated from pile driving would likely affect species present in and near the WDA during this period, with impacts ranging from avoidance behavior to mortality. The radial distance at which mortality or mortal injury, recoverable injury, and temporary reduction in hearing sensitivity (temporary threshold shift) has the potential to occur as a result of modeled peak noise level and 24-hour accumulated pile-driving noise is presented in COP Appendix III-M (Pyć et al. 2018). Given that the sound intensity level necessary to cause adverse effects on fish depends on the fish hearing category, Table 3.3-2 summarizes the radial distances that adverse sound intensities would extend from the proposed impact hammering at 6 dB attenuation. For the most sensitive fish hearing group, the threshold for potential mortality was a peak SPL of 207 dB re 1 μPa.

While eggs, larvae, sessile, and less mobile species (i.e., whelks, longfin squid egg mops) are less sensitive than some fish species to pile-driving noise, they are more vulnerable due to a lack of motility.

Although pile-driving noise would propagate across a considerable area, the primary effects on finfish and invertebrates would be temporary displacement from the affected area, recoverable injury, and temporary threshold shift. As discussed in Section 3.3.1.1, pile-driving noise could also result in reduced reproductive success in one or more spawning seasons, particularly for those species that aggregate to spawn. Potential mortality would only occur to individuals in a small area around each pile, and would primarily occur to less mobile species and life stages. However, short-term stress and behavioral changes could occur for individuals exposed to noise levels above the threshold for behavioral responses (Table 3.3-2). This could lead to increased energy expenditure and, possibly, to decreases in growth and reproductive output (COP Volume III, Section 6.6.2.1, Epsilon 2020b). Individuals displaced by pile-driving noise would be expected to return to the affected area once the noise had ceased, and pile-driving noise would not likely have any measureable effect on populations of species subject to mortality from pile-driving noise. Therefore, BOEM expects **minor** impacts on fish populations from pile driving, as it would occur sporadically, the actual area of impact would be small in relation to the overall habitat and spatial distribution of fish populations in the region, and pile-driving noise would only occur over a relatively short period of time, i.e., approximately 2 to 3 hours per foundation or up to 6 hours per day. This noise would occur intermittently for up to 102 days between May and December.

A possible impact of pile-driving noise could be a change in the presence of HMS near the WDA. If common fish and invertebrates that constitute the main prey sources for tuna, sharks, and other HMS were driven away from the WDA by noise, this could cause HMS to not remain in the area, either. Because the prey items would likely return once the noise has ceased, HMS would also be likely to return to their original behaviors and distributions. Therefore, impacts would be **minor**.

Vineyard Wind has signed an agreement with non-governmental organizations to implement enhanced mitigation. The agreement includes a promise to install no more than two jacket foundations, which could result in slightly less total noise exposure than under the maximum-case scenario.

Pelagic and demersal species may temporarily avoid non-pile driving construction noise and vessel noise, but in general, the noise would not be loud enough for long enough to induce injury or death (MMS 2009). The EFH assessment, BA, and BO summarize potential impacts on fish, invertebrates, and EFH from construction and vessel-related noise in the WDA and inter-array and export cable dredging and installation (Section 5.1.1 in BOEM 2019e; Section 5.3.2 in BOEM 2019d; Sections 7.1, 7.2, and 7.3 in NMFS 2020b). Analysis of vessel noise related to the Cape Wind Energy Project found that noise levels from construction vessels at 10 feet (3 meters) were loud enough to induce avoidance, but not physically harm fish, invertebrates, and EFH (MMS 2009). Vessel and construction noise would most likely impact pelagic species (e.g., Atlantic herring, Atlantic mackerel). To avoid vessel noise, pelagic fish typically swim down in the water column, while demersal species swim laterally along the bottom. Vessel noise may result in brief periods of exposure and would not be expected to accumulate to levels that would lead to any injury, hearing impairment or long-term masking of biologically relevant cues. NMFS does not expect vessel noise to significantly disrupt normal behavior patterns of Atlantic sturgeon, and NMFS also determined that it is extremely unlikely that any Atlantic sturgeon would be struck by proposed-Project vessels (NMFS 2020b). Because the construction vessels (tugboats, barge cranes, hopper scows) have relatively shallow drafts and the vessels and fish (within WDA and OECC) are not confined to a narrow channel, BOEM expects low vessel-related mortalities; therefore, the impact of vessel noise and traffic on finfish, invertebrates, and EFH is likely **minor**, with affected populations fully recovering following construction and installation activities.

Noise associated with operations and maintenance vessels (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2020a) would impact fish, invertebrates, and EFH in a similar way to construction vessel traffic. However, the impacts would be smaller than construction because many of the vessels used (i.e., crew transport vessels) are smaller and would be used for shorter time periods. Mobile species/life stages within range of vessel noise capable of initiating physiological stress or noise related impacts would likely move away from the source and not result in population level consequences. BOEM (2018b) determined there would not likely be an adverse effect from noise generated by vessel transit and operations, and no effect for noise generated by vessel engines and thrusters.

WTGs would also produce noise, although sound levels are typically low (Madsen et al. 2006). Measurements of the Block Island Wind Farm operational noise registered at less than 100 dB re 1 µPa at 164 feet (50 meters) from the turbine, whereas background noise levels under calm conditions were up to 110 dB at 164 feet (50 meters) from the turbine and 107 dB at 18.6 miles (30 kilometers) from the turbine (HDR 2019). According to the few available audiograms indicating fish thresholds for behavioral responses, this sound intensity would be barely detectable (Miller and Potty 2017). Sound pressure level measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa at 46 and 65.6 feet (14 and 20 meters) (Tougaard and Henrikson 2009), which is only slightly higher than the ambient noise levels recorded at the RI and MA Lease Areas from 2011 to 2015 (95 to greater than 104 dB re µPa) (Kraus et al. 2016a).When operational, WTGs would produce noise that can cause masking effects, but thus far, noise related to operational WTGs have not been found to have a negative impact on finfish (English et al. 2017). The NMFS interim criterion for behavior impacts on fish is 150 dB. In regards to invertebrates and sound, sensitivity thresholds for sound exposure have been established for few species. Mooney et al. (2016) reported evidence of behavioral responses and habituation to sound by longfin squid, and Przeslawski et al. (2018) assessed noise impacts on scallops. While no clear evidence of scallop mortality associated with seismic survey sound was found, the possibility of sub-lethal impacts was not assessed (Przeslawski et al. 2018). The lack of a swim bladder or any other gas bubble structure associated with hearing suggests their ability to hear may be most similar to fish without swim bladders (Category 1 in Table 2; Normandeau 2012). Eggs and larvae of fish are also sensitive to noise and are categorized separately with thresholds the same as fish with swim bladders not involved in hearing (Category 2 in Table 2; COP Volume III, Appendix III-M; Epsilon 2020b; Pyć et al. 2018).

Detection distance from noise generated by WTGs depends on several variables (i.e., hearing capability of fish, depth, size and spacing of WTGs, wind speed) and does not create a level of noise capable of injury (Wahlberg and Westerberg 2005). No study has shown any behavioral impact of sound during the operational phase of wind energy facilities. However, due to the lower sound emissions during operation, measurements and research remain a low priority in comparison with pile-driving sound (Thomsen et al. 2015). In light of reports of abundant finfish and invertebrates near WTG foundations (Causon and Gill 2018; English et al. 2017; ten Brink and Dalton 2018), it appears that noise from operating WTGs does not result in finfish and invertebrates avoiding WTGs or failing to thrive near them. Based on this and the above impacts associated with WTG and vessel noise, BOEM anticipates that the impacts of noise from Alternative A alone would be **minor**.

The **negligible** to **minor** impacts of noise under Alternative A alone would not increase the impacts of noise beyond the impacts under the No Action Alternative (**minor** to **moderate**). In context of reasonably foreseeable environmental trends, combined noise impacts from ongoing and planned actions, including Alternative A, would be highly similar to the impacts under the No Action Alternative and would be **minor** to **moderate**.

BOEM could further reduce impacts and help alleviate noise impacts with the following mitigation measures conditioned as part of the COP approval (Appendix D): pile-driving noise reduction; pile-driving sound source verification; and sequencing pile driving.

The use of noise-reduction technologies during all pile-driving activities to ensure a minimum attenuation of 6 dB would reduce the area impacted by noise during construction. This would ensure that the maximum distance of potential mortal injury during pile driving would be 2,618.1 feet (798 meters) of cumulative exposure for the most vulnerable fish (those with swim bladders involved with hearing) (Section A.12.1.2 and Table A-34 in Pyć et al. 2018). The specific technologies have not yet been selected; potential options include a Noise Mitigation System, Hydro-sound Damper, Noise Abatement System, a bubble curtain, or similar (Pyć et al. 2018). In addition to the use of one sound attenuation system, Vineyard Wind has committed to complete sound field verification and to have a second attenuation technology on hand, which would be deployed if sound field verification demonstrates a need for greater attenuation. Sequencing pile-driving activities to progress from offshore to inshore may reduce impacts on certain species, such as longfin squid spawning inshore, by reducing pile-driving noise at inshore locations during springtime. Although these measures would minimize noise impacts, the impacts described above would still occur, and thus the significance level of impacts would remain the same. Vineyard Wind has already committed to avoidance of all pile driving between January 1 and April 30. While this measure is primarily focused on the highly endangered North Atlantic right whale (*Eubalaena glacialis*), it would also confer benefits to cod that spawn in the winter/spring time frame. Furthermore, in regards to sequencing pile driving, Vineyard Wind has indicated it would be technically infeasible to do so given how foundation piles are designed specific to each location and installed in a way to reduce the total installation time. This measure would also likely confer greater benefits as a fishery conservation measure given that the fishery targets the same spawning aggregations that the measure is meant to protect. Additional information regarding this measure is in Appendix F, Section F.6. The other measures noted above are included in Appendix D.

BOEM has considered requiring, as a condition of COP approval, additional mitigation in the form of time-of-year restrictions on pile driving. Although the distributions and local abundances of species vary throughout the year (BOEM 2019e; Guida et al. 2017; Matt Camissa, Pers. Comm., July 25, 2018), there does not appear to be a time window in the proposed Project area that avoids all potentially sensitive finfish and invertebrates that are commercially and/or ecologically important. Therefore, the time of year restrictions are based upon periods that protect endangered species.

Presence of structures: The various types of impacts on finfish, invertebrates, and EFH that could result from the presence of structures, such as entanglement and gear loss/damage, hydrodynamic disturbance, fish aggregation, habitat conversion, and migration disturbances, are described in detail in Section 3.3.1.1.

Alternative A could result in up to 102 foundations and 152 acres (0.6 km^2) of scour/cable protection that could influence hydrodynamics and/or migration in the manner discussed above. In cases where cables become unburied, additional cable protection measures would be installed. Considering that the impacts of the presence of structures on finfish, invertebrates, and EFH via alterations to hydrodynamics and/or migration are anticipated to be highly localized and to vary seasonally, and that Alternative A would involve no more than 102 foundations, these impacts would likely be **negligible**.

Long-term habitat alteration would occur in the form of installation of the foundations, scour protection around the WTG and ESP foundations, as well as cable protection for the inter-array and export cables. Temporary habitat alteration would occur from activities associated with WTG and ESP construction and installation of the inter-array and export cable. As described in Section 3.2, the total area of alteration within the WDA due to foundation and scour protection installation, jack-up vessel use, inter-array and inter-link cable installation, and potential cable protection installation is 393 acres (1.6 km^2), which is 0.5 percent of the entire WDA (Tables 3.2-2 and 3.2-3). As listed in Tables 3.2-2 and 3.2-3, the amount of bottom habitat altered within the OECC by cable protection would be approximately 35 acres (0.1 km^2) or less. As discussed in Sections 3.1 and 3.2, portions of the areas of hard-bottom habitat along the OECC could be converted to soft-bottom habitat during cable installation. The OECC installation and sand wave dredging along the route would result in a temporary disturbance of up to 117 acres (0.5 km^2) and 69 acres (0.3 km^2) of seafloor habitat, respectively.

Eelgrass EFH HAPC for juvenile and adult summer flounder would not be affected by the proposed Project because it would be avoided, but HAPC for juvenile Atlantic cod could be affected. All of the hard-bottom habitat within the proposed Project OECC would be considered HAPC for juvenile Atlantic cod, as would some other habitat types not mapped. As discussed in Section 3.1, some hard-bottom habitat in the OECC would be altered by cable burial, and it is possible that new hard-bottom habitat could be created by cable protection. The total amount of juvenile Atlantic cod HAPC that could be altered by the presence of structures added by the proposed Project is not known, but would not exceed the total area of cable protection within the OECC, namely 35 acres (0.14 km^2) (Table 3.2-2). These alterations to hard-bottom habitat are unlikely to have a population-level impact on species with designated EFH in the area, as the total habitat disturbance within the WDA and OECC, including temporary, long-term, and permanent alterations, would affect a small fraction of the designated HAPC (COP Volume III, Section 4.2.2; Epsilon 2020b; Epsilon 2018b; BOEM 2019e).

Replacement of soft-bottom habitat with hard-bottom habitat would benefit some species (i.e., American lobster, Atlantic cod) while reducing habitat for others (i.e., winter flounder, American sand lance [*Ammodytes americanus*]). The installation of foundations and scour protection would cause some displacement of mobile finfish and invertebrate species that prefer soft-bottom habitat (i.e., flatfish). Sessile species (i.e., shellfish, demersal eggs) in the immediate area would likely be subject to mortality. Conversely, species preferring hard-bottom habitat (i.e., Atlantic cod, American lobster) would have increased habitat availability from scour protection around foundations. This could tend to alter the distribution of species. However, temperature is expected to be a bigger driver of habitat occupation and species movement through the WDA as a whole (Secor et al. 2018). Although the vertical surfaces on WTG and ESP monopiles would also introduce a source of new hard substrate, the dominant community after several years of succession is not anticipated to be highly diverse, based upon the almost singular colonization of foundations by blue mussels observed at the Block Island Wind Farm (HDR 2019) and the dominance of blue mussels and/or sea anemones observed at wind energy facilities in the Belgian part of the North Sea (Kerckhof et al. 2019). New hard surfaces might provide a favorable substrate for exotic invasive species (Langhamer 2012), potentially leading to further impacts. BOEM expects **moderate** negative impacts from the long-term conversion of habitat, although this could be **beneficial** for fish and invertebrates that prefer hard-bottom communities. Impacts associated with long-term habitat alteration are an unavoidable consequence of construction and installation. Because the long-term habitat alteration from soft to hard-bottom habitat would encompass a proportionally small area relative to the WDA as a whole, these impacts are unlikely to have substantial effects on populations in the WDA, as displaced species would have large areas of preferred habitat available nearby (Guida et al. 2017; COP Volume II-A, Section 2.1.2.1 and Appendix II-I, Chart 2; Epsilon 2018a).

WTG and ESP foundations could affect pelagic species and life stages. A modeling study by Chen et al. (2016) found that WTGs in the region would not have a significant influence on southward larval transport during storm events, although foundation placement could either increase or decrease larval dispersion and speed, depending on initial location; however, the models never found the foundations to trap or block larvae. For calmer conditions, tank tests, such as the one conducted by Miles et al. (2017), conclude that mean flows are reduced immediately downstream of an offshore wind monopile foundation, but return to background levels within a distance proportional to the pile diameter (D). In a current-only regime, mean flows returned to within 5 percent of background levels by approximately 8.3 D away from the pile. In a combined current and wave regime, flow returned to background levels within 3.5 D. Miles et al. (2017) suggested a rule of thumb that downstream effects have a length scale of 8 to 10 D. Thus, this research if applied to the Vineyard Wind 1 Project would mean that background conditions would exist approximately 328 feet (100 meters) from each monopile foundation. WTGs could also increase the mixing of surface waters and deepen the thermocline, possibly increasing pelagic productivity in local areas (English et al. 2017), although this would likely have little effect on finfish and commercially important invertebrates. A field survey of a Dutch wind energy facility found no effect of the wind energy facility on bivalve recruitment (Bergman et al. 2010). Considering that potential effects on the pelagic environment are likely to be non-measureable and localized, BOEM expects impacts of pelagic changes to be **negligible**.

Cable protection and scour protection around WTG and ESP foundations could create an artificial reef effect and attract a different community of fish and invertebrates, and shift the habitat from a benthic soft-bottom to hard-bottom habitat, although it may or may not function similarly to hard-bottom habitat typical in the region (Kerckhof et al. 2019; HDR 2019). Species preferring hard-bottom habitat (i.e., Atlantic cod, American lobster) would gain habitat while soft-bottom species (summer flounder, Atlantic surfclam) would see habitat locally reduced. The reef effect has been observed around WTGs, leading to local increases in biomass and diversity (Causon and Gill 2018). Invertebrate and fish assemblages may develop around these reef-like elements within the first year or two after construction (English et al. 2017). Although some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the reef effect results in increased productivity versus simply attracting and aggregating fish from the surrounding areas (Causon and Gill 2018). For the Cape Wind Energy Project, the Minerals Management Service did not anticipate the vertical monopile structures to provide a true artificial reef due to the material and low quantity of interstitial spaces available, in contrast to the rocky scour protection (MMS 2009); however, recent observations at the Block Island Wind Farm have reported considerable colonization by mussels (ten Brink and Dalton 2018). Similar to scour protection, the offshore export cable could require protection (e.g., rock or concrete mattresses) in places where it is not buried to the minimum target burial depth of 5 feet (1.5 meters). However, Vineyard Wind has committed to prioritizing cable burial and to using iterative analyses of survey data along the OECC, advanced burial techniques (e.g., vertical injector jetting), and micro-routing to ensure burial and minimize the need for cable protection (Epsilon 2018c). To comply with the Nantucket Order of Conditions (Nantucket Conservation Commission 2019), Vineyard Wind would use natural stone where cable protection is necessary within waters under the jurisdiction of the Town of Nantucket (i.e., a portion of the OECC near Muskeget Channel); Vineyard Wind would continue to evaluate the feasibility of the use of natural stone in other locations.

The potential effects of wind energy facilities on offshore ecosystem functioning has been studied using simulations calibrated with field observations (Raoux et al. 2017; Pezy et al. 2018; Wang et al. 2019). These studies indicated that wind energy facilities may increase bivalve biomass and shift local food webs toward a greater amount of detritivory. They also indicated higher biomass for benthic fish and invertebrates and possibly for pelagic fish, marine mammals, and birds as well. Overall, omnivory, energy recycling, and general ecosystem activity were all predicted to increase after wind energy facility construction. This indicates that offshore wind energy facilities can generate positive impacts on local ecosystems.

In light of the above information, BOEM expects **moderate beneficial** impacts associated with reef effect, although impacts on a population level for most species should be minimal, based on the amount of habitat converted in relation to the overall habitat still available in the region.

A potential effect of the existence of offshore cables and structures is the entanglement and loss of commercial and recreational fishing gear. This could affect finfish, invertebrates, and EFH by modifying habitat and possibly trapping, injuring, or killing finfish and invertebrates. Although these impacts would likely be **negligible**, BOEM could further reduce these impacts by requiring annual monitoring, reporting, and removal of monofilament and other fishing gear around foundations, cables, and scour protection (Appendix D).

One unexplored potential effect of offshore wind power facilities is that of the shadow flicker caused by rotating WTG blades. Although no study has assessed the effect of shadow flicker on finfish or invertebrates, it is possible that those species that perceive shadows as indicative of predators could be affected, especially when those individuals encounter shadow flicker while near the surface. Although this potential effect is currently hypothetical, its impact would likely be **negligible**.

The **negligible** to **moderate** impacts of Alternative A alone would not increase the impacts beyond those of the No Action Alternative. Using the assumptions in Appendix A, there could be up to approximately 1,221 acres (4.9 km^2) of new hard protection atop cables. Of this area, 98 acres (0.4 km^2) would result from Alternative A, and the remainder is the estimated result of other offshore wind projects in the geographic analysis area for finfish, invertebrates, and EFH. The total area of soft-bottom habitat that would be modified is less than 0.002 percent of available soft-bottom habitat in the geographic analysis area for finfish, invertebrates, and EFH. The total number of foundations, the amount of scour protection, and the amount of cable protection would be the same under Alternative A and under the No Action Alternative. The structures and the consequential impacts would remain at least until decommissioning of each facility is complete. In context of reasonably foreseeable environmental trends, the combined impacts of this IPF on finfish, invertebrates, and EFH from ongoing and planned actions, including Alternative A, would likely include **moderate** impacts and possibly **moderate beneficial** impacts.

BOEM could require Vineyard Wind, as a condition of COP approval, to use cable protection materials that meet certain criteria (Appendix D). This measure would increase the probability of recolonization by benthic organisms and use of the introduced substrate as habitat by finfish and invertebrates. Therefore, this would reduce the degree of adverse impacts from cable protection on finfish, invertebrates, and EFH and enhance the degree of possibly beneficial impacts on some finfish and invertebrates although the significance level of impacts would remain the same. BOEM could also require Vineyard Wind, as a condition of COP approval, to minimize foundation scour protection (Appendix D). This mitigation measure could reduce the expected impacts of habitat conversion by minimizing the area affected by scour protection, although the significance level of impacts would remain the same.

Regulated fishing effort: Regulated fishing effort can affect finfish, invertebrates, and EFH by modifying the nature, distribution, and intensity of fishing-related impacts (mortality, bottom disturbance). Alternative A and other future offshore wind development could influence this IPF (Section 3.10), possibly influencing when, where, and to what degree fishing activities affect finfish, invertebrates, and EFH. The intensity of impacts on finfish, invertebrates, and EFH under future fishing regulations is uncertain, but would likely be similar to or less than under the status quo, and would likely qualify as **moderate**.

Seabed profile alterations: The dredging potentially involved in Alternative A could affect up to 69 acres (0.3 km^2), resulting in temporary seabed profile alterations. These bathymetric changes would create narrow troughs or flats in fields of sand waves, changing the character of the seafloor as finfish and invertebrates habitat. BOEM anticipates that the corresponding impacts on finfish, invertebrates, and EFH would be **minor** and would dissipate over time as mobile sand waves fill in the altered seabed profile.

The **minor** impacts of Alternative A alone would not increase the impacts beyond those of the No Action Alternative because, according to the assumptions stated in Appendix A, the 69 acres (0.3 km^2) of dredging in Alternative A does not add to the amount of dredging under the No Action Alternative, but rather it preempts an equal amount that might otherwise have occurred at a later time. Although the amount of seabed profile alteration in the No Action Alternative is not known, it is likely to be on the order of 20 times more than Alternative A. In context of reasonably foreseeable environmental trends, the combined impacts of this IPF on finfish, invertebrates, and EFH from ongoing and planned actions, including Alternative A, would likely be **minor**.

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredging methods (Appendix D). This would reduce the area and degree of dredging-related impacts compared to the maximum-case scenario, possibly reducing the level of the impacts of Alternative A alone on finfish, invertebrates, and EFH via seabed profile alterations.

Sediment deposition and burial: Sediment deposition can impact finfish, invertebrates, and EFH by covering habitat, smothering sessile organisms or life stages, and causing mobile species to avoid or abandon habitat. COP Appendix A models sediment deposition in the WDA and OECC from construction and installation activities

(Volume III, Appendix III-A; Epsilon 2020b). Mobile species of finfish and invertebrates (e.g., flatfish) would likely avoid or abandon deposition areas. Slow-moving but mobile species (e.g., Jonah crabs, horseshoe crabs, whelks, scallops) may not be able to escape the affected area, but would likely be able to uncover themselves during and after sedimentation. Sessile species are often capable of handling some degree of sediment deposition because turbidity and sedimentation occur naturally in soft-bottom habitats (e.g., during storm events; Wilber et al. 2005). Sediment deposition could bury demersal eggs and newly settled bivalve spat (i.e., American oyster spat, longfin squid egg mops, Atlantic wolffish eggs, whelk egg cases and hatchlings), leading to sub-lethal effects or mortality. Wilber and Clarke (2001) found reduced feeding and respiratory rates in oysters when exposed to deposition from dredging. Mortality can occur to sessile shellfish in sedimentation levels greater than 0.8 inches (20 millimeters) (Wilber and Clarke 2001; COP Volume III, Section 6.5.2.1.3; Epsilon 2020b). Benthic eggs and larvae (e.g., whelks, winter flounder, longfin squid egg mops) are more susceptible to increased mortality rates in depositions over 0.04 inches (1 millimeter) (Wilber and Clarke 2001; Berry et al. 2011). Sediment deposition covering hard-bottom habitat along the OECC could temporarily impact juvenile Atlantic cod HAPC (Figure 1 in BOEM 2019e) and could negatively impact the settlement of bivalve larvae (Wilber and Clarke 2001). Based on the limited distribution of sediment depositions exceeding 0.04 inches (1 millimeter) along the OECC and the overall proportion of the affected soft-bottom habitat in relation to that available regionally, BOEM expects temporary **minor** impacts, with affected populations completely recovering following construction activities. Please refer to the EFH assessment, BA, and BO for additional information on potential impacts on fish, invertebrates, and EFH for proposed-Project activities (Section 5.1.2 in BOEM 2019e; Section 5.3.1 in BOEM 2019d; Section 7.3 in NMFS 2020b).

The **minor** incremental impacts of Alternative A would not increase the impacts beyond those of the No Action Alternative because, according to the assumptions stated in Appendix A, the approximately 2,594 acres [10.5 km^2] subject to sediment deposition in Alternative A does not add to the amount of sediment deposition under the No Action Alternative, but rather it preempts an equal amount that might otherwise have occurred at a later time. Although the amount of sediment deposition in the No Action Alternative is not known, it is likely to be on the order of 20 times more than Alternative A. In context of reasonably foreseeable environmental trends, the combined impacts of this IPF on finfish, invertebrates, and EFH from ongoing and planned actions, including Alternative A, would likely be **minor**.

BOEM could require Vineyard Wind, as a condition of COP approval, to restrict its dredge disposal sites (Appendix D). This could minimize impacts on sensitive habitats and allow for the identification of potential remedial efforts if misplacement of materials were to occur. Although this could reduce the impacts of burial during dredged material disposal, the sediment deposition impacts described above would still occur; therefore, the significance level of impacts would remain the same.

Climate change: This IPF would contribute to the reduced growth or decline of invertebrates that have calcareous shells, alterations in migration patterns, and increased disease frequency. BOEM anticipates that Alternative A alone would have no measureable influence on this IPF. Because this IPF is a global phenomenon, the impacts through this IPF would be the same as those under the No Action Alternative. The intensity of impacts resulting from climate change are uncertain, but are anticipated to qualify as **minor** to **moderate**.

Other considerations: Although BOEM's BA for Alternative A (BOEM 2019d) considered the potential for impacts on the Atlantic sturgeon from various IPFs, NMFS's BO determined that the Proposed Action is not likely to adversely affect any DPS of Atlantic sturgeon (NMFS 2020b). BOEM does not anticipate that any Atlantic sturgeon would be seriously injured or killed as a result of exposure to any IPF. In context of reasonably foreseeable environmental trends, the Atlantic sturgeon may experience impacts of ongoing and planned actions. The most significant IPF for individual sturgeon is likely to be noise from pile driving; however, even considering the expanded offshore wind scenario, effects to individual Atlantic sturgeon are expected to be limited to temporary behavioral disturbance. As such, Alternative A and ongoing and reasonably foreseeable actions are not anticipated to result in adverse population consequences.

Impacts associated with decommissioning would be similar to the impacts of the construction phase. WTG and ESP foundation and scour protection removal would have the same temporary habitat impacts as construction (with the exception that there would be no pile driving). Decommissioning activities include removing Project components, including WTGs and ESPs, to 15 feet (4.6 meters) below the mudline (Section 2.1.1.3). The portion buried below

15 feet (4.6 meters) would remain, and Vineyard Wind would refill the depression with sediment. Vineyard Wind would also remove the scour protection and hard protection atop cables. Acoustic effects would reflect those associated with non-pile-driving noise that was associated with construction and installation and the operations and maintenance activities, and are unlikely to have long-term negative impacts. Therefore, BOEM anticipates **minor** impacts. Removal of the scour protection would result in temporary and long-term habitat alterations from removal of hard-bottom habitat and disruption of soft-bottom habitat due to cable and scour protection removal. These temporary and long-term alterations would have similar impacts as those discussed during construction and installation activities. Removal of the hard-bottom habitat would likely result in a recolonization of species preferring soft-bottom habitat and the loss of any species that previously colonized and maintained populations on the hard-bottom habitat. BOEM anticipates **minor** impacts on species and their preferred habitats.

In summary, activities associated with the construction and installation, operations and maintenance, and decommissioning in the WDA and OECC would impact fish, invertebrates, and EFH to varying degrees. Impacts associated with Proposed Action activities would be specific to the life stage and habitat requirements of a species. Activities that primarily impact benthic habitat (i.e., cable installation, scour protection) are not as likely to impact species or life stages that depend on pelagic habitats. Conversely, the above-mentioned activities are likely to displace or kill benthic species and life stages such as skates, flatfish, squid egg mops, and Atlantic sea scallops. The continued presence of foundations could affect pelagic habitat. BOEM anticipates the impacts resulting from Alternative A alone would range from **negligible** to **moderate**, including the presence of structure, which may result in **moderate beneficial** impacts; overall, the impacts of Alternative A alone on finfish, invertebrates, and EFH would likely be **moderate**. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.3.1.2. Although some of the proposed activities and/or IPFs analyzed could overlap, BOEM does not anticipate that this would alter the overall impact rating of **moderate**, because it would neither appreciably diminish the aforementioned impacts nor increase them to such a degree that a regional or population-level impact on the affected resource would not fully recover, even after the impacting agent is gone and remedial or mitigating action is taken. Alternative A would be more likely to impact benthic species, life stages, and EFH than pelagic species and EFH, since the majority of activities affect benthic habitat. Turbidity, especially associated with dredging, and water withdrawal from jet plowing could temporarily impact pelagic eggs and larvae and EFH. Pile-driving noise, although temporary, could impact all benthic and pelagic life stages. The operational phase of Alternative A could lead to uncertain but possibly beneficial effects on finfish, invertebrates, and EFH through altering the pelagic environment and through the reef effect. The adverse impacts associated with the construction and installation, operations and maintenance, and decommissioning of Alternative A are likely to be temporary and/or small in proportion to the overall habitat available regionally. Vineyard Wind may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above, but doing so would not likely result in different impact ratings than those described above.

In the context of other reasonably foreseeable environmental trends in the area, impacts of individual IPFs resulting from planned actions, including Alternative A, would range from **negligible** to **moderate** and **moderate beneficial**. Considering all the IPFs together, BOEM anticipates that the impacts from ongoing and planned actions, including Alternative A, would result in **moderate** impacts on finfish, invertebrates, and EFH in the geographic analysis area. The main drivers for this impact rating are fishing mortality, climate change, recurring bottom disturbance from bottom-tending fishing gear, and mortality resulting from offshore construction. Alternative A would contribute to the overall impact rating primarily through the temporary disturbance due to new cable emplacement and permanent impacts from the presence of structures (cable protection measures and foundations). BOEM has considered the possibility of a **major** impact resulting from invasive species; this level of impact could occur if an invasive species were to adversely impact ecosystem health or habitat quality at a regional scale. While it is an impact that should be considered, it is also unlikely to occur. Invasive species have already been documented on Georges Bank, and the risk of impacts within the analysis area would be highly similar under the No Action Alternative or under Alternative A, as ongoing activities (e.g., shipping and marine debris) contribute most of the risk through this IPF. Thus, the overall impacts on finfish, invertebrates, and EFH would likely qualify as **moderate** because a notable and measurable impact is anticipated, but the resource would likely recover completely when the impacting agents were gone and remedial or mitigating action were taken.

Vineyard Wind has signed an agreement with non-governmental organizations to implement enhanced mitigation (Vineyard Wind et al. 2019). The agreement includes a promise to install no more than two jacket foundations, which would result in less installation impact than under the maximum case otherwise. However, this would not change the level of impacts on finfish, invertebrates, and EFH. In addition, MassDEP, pursuant to the Town of Nantucket wetlands protection bylaw, has instituted the following requirements for the portion of the proposed work in Nantucket waters: (1) Vineyard Wind must obtain the approval of MassDEP for the final benthic monitoring plan, (2) Vineyard Wind must provide an updated bottom profile survey including video documentation, (3) any cable armoring must consist of natural materials that mimic the surrounding seafloor, (4) a post-construction survey and annual reporting must demonstrate any impacts, (5) if a report shows any adverse impact, Vineyard Wind must provide a detailed mitigation or restoration plan (Nantucket Conservation Commission 2019). Appendix D provides details.

While the significance level of impacts would likely remain the same, BOEM could further reduce impacts with the following mitigation measures conditioned as part of the COP approval (Appendix D), as discussed under the relevant IPFs above:

- Requiring Vineyard Wind to develop and implement an anchoring plan;
- Requiring the evaluation of additional benthic habitat data prior to construction;
- Restricting dredging and cable installation methods and timing;
- Requiring pile-driving sound source verification;
- Requiring periodic underwater surveys, reporting, and monofilament and other fishing gear clean up around WTG foundations;
- Allowing only certain types of cable protection;
- Minimizing foundation scour protection;
- Requiring sound attenuation of at least 6 dB along with a soft-start technique; and
- Restricting, documenting, and reporting of the locations of dredged material disposal sites.

While monitoring would not reduce impacts of the Proposed Action, BOEM could evaluate impacts, refine current knowledge of finfish, invertebrate, and EFH resources, and inform Vineyard Wind's decommissioning procedures, as well as others planning similar future projects, to assist in selecting the least impactful method(s). BOEM may require the following monitoring measures conditioned as part of the COP approval (Appendix D):

- Pre- and post-installation bottom profiling and video monitoring along the offshore export cable route;
- Plankton surveys, trawl surveys, ventless trap surveys, and optical surveys of benthic invertebrates and habitat;
- Using PAM to record ambient noise in the lease area before, during, and after construction;
- Reporting any fish kills near pile-driving activities; and
- Additional review and comment on the benthic monitoring plan.

3.3.3. Consequences of Alternatives C, D1, D2, and E

Alternative C would relocate six of the northernmost WTG locations to the southern portion of the WDA primarily for the purpose of reducing visual impacts and minimizing conflicts with commercial fishing boats. Alternative D1 increases the spacing between WTGs in the WDA to 1 nautical mile to reduce potential conflicts with ocean uses. Alternative D2 would align WTGs in an east-west orientation with a 1 nautical mile spacing between all turbines to allow greater spacing between WTG rows, which would facilitate the established practice of mobile and fixed gear fishing vessels. New geotechnical and/or engineering surveys necessary to determine the new WTG placements would temporarily disturb habitat for fish, invertebrates, and EFH, which would cease after completion. Therefore, BOEM anticipates impacts associated with these surveys would be **minor**. Alternative E would allow no more than 84 WTGs.

All other design parameters and potential variability in design would be the same as under Alternative A. This assessment analyzes the maximum-case scenario; any potential variances in the proposed-Project build-out as defined in the PDE (i.e., numbers and spacing of WTGs and ESPs, length of inter-array cable) or construction activities would result in similar or lower impacts than described below. For example, if Vineyard Wind were to use fewer, larger WTGs and less total length of cable, impacts resulting from the installation and operation of these elements would be less than the maximum described in this analysis.

The impacts of Alternative C alone would be very similar to those under Alternative A because shifting WTGs to a more southern location under Alternative C within the WDA would not alter the size of the WDA footprint, and thus would not impact the amount or quality of habitat altered. The impacts of Alternatives D1 and D2 alone on finfish, invertebrates, and EFH would be similar to, but slightly greater than, those of Alternative A due to an increase in inter-array cable. Recent forecasts by Vineyard Wind estimate that the length of inter-array cabling would be approximately 186.4 miles (300 kilometers) under Alternative D1 or D2, which exceeds the maximum design parameter in the COP PDE of 171 miles (275 kilometers). While increases in turbidity, water withdrawal, and sediment deposition would cover a larger area, the overall impacts would remain the same as Alternative A. Alternatives D1 and D2 might slightly reduce the intensity of WTG noise due to the greater spacing between WTGs, although the noise would be spread over a larger area and the overall impact of this operational activity would remain **minor**. The impacts of Alternative E alone would be less than those of Alternative A alone because IPFs associated with the installation of WTGs, including pile-driving noise, temporary habitat disturbance, turbidity, and sediment deposition, would be reduced by approximately 16 percent compared to the maximum-case scenario under Alternative A. However, the level of impact on finfish, invertebrates, and EFH under Alternative E would still be of a similar level to that of Alternative A. Overall, the impacts of Alternatives C, D1, D2, or E alone on finfish, invertebrates, and EFH would likely be **moderate**, including the presence of structure, which may result in **moderate beneficial** impacts, as described in Section 3.3.2.1.

Impacts under Alternative C, D1 or D2 may interact with slight changes in fish and invertebrate communities that could occur with changing location and depth in a different portion of the WDA, but BOEM anticipates these changes to be insignificant, based on the similarity of sediments and invertebrate communities across the WDA (COP Volume II-A, Appendix H-4; Epsilon 2018a). A possible impact of reducing conflict with commercial fishing vessels is the potential for a lesser reduction in harvests of commercial species that might otherwise be more difficult to harvest under Alternative A. Overall, the difference in commercial fishing pressure should be biologically insignificant in relation to existing commercial fishing harvests regionally.

In context of reasonably foreseeable environmental trends, the impacts of ongoing and planned actions, including Alternatives C, D1, D2, and E, would not differ from those under Alternative A (with individual IPFs leading to impacts ranging from **negligible** to **moderate** and **moderate beneficial**). While Alternative E may be slightly less impactful to finfish, invertebrates, and EFH than Alternative A and Alternative D1 or D2 may be slightly more impactful than Alternative A, the impacts under Alternatives C, D1, D2, or E would be similar to the impacts under Alternative A. In context of reasonably foreseeable environmental trends, the overall impacts on finfish, invertebrates, and EFH of ongoing and planned actions, including Alternatives C, D1, D2, or E, would be the same level as under Alternative A—**moderate**. This impact rating is driven mostly by ongoing activities, such as fishing mortality, climate change, and bottom-tending fishing gear, as well as by the construction, installation, and presence of other offshore wind structures.

As described above, Vineyard Wind's existing commitments to mitigation measures and BOEM's potential additional mitigation measures could further reduce impacts, but would not change the impact ratings.

3.3.4. Consequences of Alternative F

The impacts of Alternative F alone on finfish, invertebrates, and EFH would be greater than those of Alternative A alone because the length of inter-array cabling would increase and would likely exceed the maximum design parameter in the COP PDE of 171 miles (275 kilometers) due to the need to traverse a 2- or 4-nautical-mile transit lane. The seafloor area affected in the course of inter-array cable installation and operations and maintenance would also increase. Recent forecasts by Vineyard Wind estimate that the length of inter-array cabling would be approximately 221 miles (355 kilometers) under Alternative F with a 4-nautical-mile transit lane and Alternative A layout, and 234 miles (376 kilometers) with a 4-nautical-mile transit lane and the Alternative D2 layout. If the transit lane were only 2 nautical miles wide, the length of inter-array cabling would still exceed that in the COP PDE but would be somewhat less than with a 4-nautical-mile transit lane. Finfish, invertebrates, and EFH in an area up to 279 acres (1.13 km^2) could be affected by installation of inter-array cable under Alternative F, compared to up to

204 acres (0.83 km^2) under the PDE in the COP. The natures of these impacts are not likely to be substantially different from those under other alternatives because the seafloor of the Wind Lease Area is relatively homogenous. Up to approximately 84 acres (0.34 km^2) of benthic habitat could be affected by installation of cable protection atop the inter-array cable under Alternative F, compared to the up to 61 acres (0.25 km^2) under the PDE in the COP. This is a conservative estimate, considering that Vineyard Wind expects that cable protection is less likely to be needed in the WDA, due to consistent geology to the cable burial depth with limited coarse material. Combining this increased cable protection with the maximum impact of foundations and scour protection, which have not changed, up to approximately 139 acres (0.56 km^2) in the WDA would be converted from the existing habitat to rock/hard-bottom habitat under Alternative F, compared to the approximately 117 acres (0.47 km^2) under the PDE in the COP.

Additional site characterization surveys may cause local temporary impacts that are difficult to detect. Slight changes in finfish and invertebrate communities could occur with changing location and depth of proposed-Project impacts in a different portion of the lease area, but BOEM anticipates these changes to be insignificant, based on the similarity of sediments and invertebrate communities across the WDA (COP Volume II-A, Appendix H-4; Epsilon 2018a). Therefore, expanding the WDA and shifting some activities and structures to the south/southwest would not likely affect different finfish, invertebrates, and EFH or change the nature of potential impacts on finfish, invertebrates, and EFH. For the same reason, the potential impacts on finfish, invertebrates, and EFH of Alternative F do not depend on the other turbine layout constraints (Alternative A, Alternative D2, or any other alternative) or on the width of the transit lane (2 nautical miles or 4 nautical miles), with the exception that a greater amount of cable would lead to greater impacts. While Vineyard Wind would have the liberty to configure the inter-array and inter-link cables within the bounds established by the final approved COP, the minimum cable length technically necessary to connect enough WTGs to meet the 800 MW generation capacity in the COP (and thus, the impacts of the cable on finfish, invertebrates, and EFH) would likely be shortest for a 2-nautical-mile transit lane combined with the layout of Alternative A (or Alternative E) and the longest for a 4-nautical-mile transit lane combined with the layout of Alternative D2. Overall, the impacts of Alternative F alone on finfish, invertebrates, and EFH would likely be **minor** to **moderate**, including the presence of structure, which may result in **moderate beneficial** impacts.

Because the transit lanes are generally not oriented to existing fishing patterns, it is not anticipated that there would be an increase in the utilization of bottom-tending fishing gear in the transit lane. Thus, the difference in commercial fishing pressure between Alternative F and Alternative A would likely be biologically insignificant in relation to existing commercial fishing harvest regionally.

In considering the collective impacts of Alternative F among other planned actions, BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. In context of reasonably foreseeable environmental trends, the impacts of planned actions, including Alternative F, would be similar to those under Alternative A (with individual IPFs leading to impacts ranging from **negligible** to **moderate** and **moderate beneficial**).

BOEM has qualitatively evaluated the collective impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. To the extent additional transit lanes are implemented in the future outside of the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located further from shore, similar to the proposed Project under Alternative F. As a result, establishment of additional transit lanes could require increased lengths of offshore export cable and therefore increased effects to finfish, invertebrates, and EFH. This could result in some activities that are uncertain and may lead to greater, lesser, or similar impacts on finfish, invertebrates, and EFH. If all the proposed transit lanes were implemented, this would not allow the technical capacity of offshore wind power generation assumed in Chapter 1 to be met. Specifically, assuming that all WTGs would be of 12 MW capacity, an estimated 800 foundations (784 WTGs and 16 ESPs) within the RI and MA Lease Areas would be required to meet the offshore energy demand.[4] Implementation of all six transit lanes with 4-nautical-mile transit lanes and a 1- by 1-nautical-mile WTG layout would only allow space for a maximum of 736 foundations. Implementation of all six transit lanes with 2-nautical-mile transit lanes and a 1 by 1-nautical-mile WTG layout would only allow space for a maximum of 903 foundations. If in the future all six transit lanes were

[4] If the WTG sizes specified in Appendix A are assumed, a total of 975 foundations would be required.

implemented with 4-nautical-mile width and/or Alternative A layout, there may not be enough space to develop power generation capacity to meet demand in Massachusetts, Rhode Island, and New York. Therefore, impacts under this scenario would likely fall somewhere between the impacts of Alternative A (or of Alternative D2) and the impacts of Alternative F with 4-nautical-mile transit lanes and the proposed Project layout per Alternative D2.

Overall, the impacts of Alternative F alone on finfish, invertebrates, and EFH would likely be **minor** to **moderate**, including the presence of structure, which may result in **moderate beneficial** impacts. In context of reasonably foreseeable environmental trends, the overall impacts on finfish, invertebrates, and EFH of ongoing and planned actions, including Alternative F, would be of the same level as under Alternative A—**moderate**. The width of the transit lane and the other alternative(s) with which Alternative F is combined could slightly modify the amount of impacts by modifying the amount of incremental impact, as discussed above; however, the overall level of impacts would be similar for any contemplated version of Alternative F (**moderate**), which is driven mostly by ongoing activities, such as fishing mortality, climate change, bottom-tending fishing gear, as well as by the construction, installation, and presence of other offshore wind structures.

As described above, Vineyard Wind's existing commitments to mitigation measures and BOEM's potential additional mitigation measures could further reduce impacts, but would not change the impact ratings.

3.3.5. Comparison of Alternatives

As discussed above, the impacts associated with Alternative A alone do not change substantially under Alternatives C through F. Although the amount of impacts from cabling varies slightly among alternatives, the overall level of impacts would be similar for these alternatives. It is also important to note that Alternative E would reduce the potentially beneficial impacts as well as reduce the potentially adverse impacts. Alternative F would have impacts on finfish, invertebrates, and EFH that would be greater than those of Alternative A because the length of inter-array cabling and the extent of the WDA would increase. Furthermore, in context of reasonably foreseeable environmental trends, the impacts on finfish, invertebrates, and EFH would be slightly lower under Alternative E than under the maximum-case scenario in any other action alternative; however, the overall impact of any action alternative when combined with other planned actions would be similar because the majority of the impacts result from ongoing activities and other future offshore wind projects. See Table 2.4-1 for a comparison of alternative impacts.

3.3.6. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. The mitigation measures may reduce impacts on this resource, but would not necessarily change the impact ratings. Thus, no WTGs or inter-array cable would be placed within the northernmost portion of the WDA, more WTGs and inter-array cable may be placed in the southern portion of the WDA and may extend beyond the limits of the WDA proposed in the COP, although not beyond the boundaries of Lease Area OCS-0501, and no more than 84 WTGs would be allowed. The Preferred Alternative would reduce impacts related to WTGs by approximately 16 percent compared to Alternative A. The length of inter-array cabling would be approximately 186.4 miles (300 kilometers), which exceeds the maximum design parameter in the COP PDE of 171 miles (275 kilometers) (Michael Clayton, Pers. Comm., March 24, 2020). The impacts associated with the Preferred Alternative cable installation (habitat alteration, sediment deposition, turbidity, water withdrawal) would remain the same level as for Alternative A (**moderate**). BOEM anticipates impacts from operations and maintenance and decommissioning would be the same as Alternative A.

Construction methods for the Preferred Alternative would be identical to those of Alternative A, but the proposed Project footprint in the WDA would be considerably less due to the reduced number of WTGs and associated inter-array cabling. The Preferred Alternative would convert approximately 16 percent less habitat in the WDA to hard-bottom habitat from the reduction in the number of WTGs and associated scour protection, and impacts associated with WTG installation, including pile driving, temporary habitat disturbance, turbidity, and sediment deposition would also be reduced due to the reduction in WTGs, decreasing the overall impacts on finfish, invertebrate, and EFH resources in the region. The effects of the offshore export cable would be the same as those of Alternative A. Impacts on the endangered Atlantic sturgeon, which NMFS determined to be insignificant or extremely unlikely to occur under the Proposed Action (NMFS 2020b), would also be insignificant or extremely unlikely under the

Preferred Alternative. While the construction-related activities discussed would be reduced in scope, the impacts associated with each activity would remain the same, since the conversion of existing habitat to a new type of hard-structure habitat would still have a **moderate** impact, just on a lesser scale. The Preferred Alternative would reduce WTG noise impacts due to the reduced number of WTGs, although the overall impact would not change. The reduced number of WTGs and assumed reduction in vessel activity may result in a reduced likelihood of spills. Should they occur, oil and chemical spills would have the same impact as in Alternative A: **negligible** for small spills and **moderate** for larger spills. Thus, the level of impacts from individual IPFs under the Preferred Alternative would likely range from **negligible** to **moderate** and **moderate beneficial** and the overall impact would be **moderate**.

3.4. MARINE MAMMALS

3.4.1. No Action Alternative and Affected Environment

This section discusses existing marine mammal resources in the geographic analysis area for marine mammals, as described in Table A-1 in Appendix A and shown in Figure A.7-5, namely, the Scotian Shelf, Northeast Shelf, and Southeast Shelf LMEs, which are likely to capture the majority of the movement range within U.S. waters for most species in this group. Table 3.4-1 contains a detailed summary of baseline conditions and the anticipated impacts based on the IPFs assessed, and of ongoing and future offshore activities other than offshore wind, which is discussed below.

Marine mammals are a diverse group of approximately 130 species, although the exact number of formally recognized marine mammal species changes periodically with new scientific understanding or findings (Rice 1998). For a list of current species classifications, see the formal marine mammal species and subspecies list maintained online by the Society for Marine Mammalogy at https://www.marinemammalscience.org/.

Regarding terminology used to describe types of marine mammals herein, the term “pinnipeds” refers to seals; “odontocetes” refers to toothed whales, dolphins, and porpoises; the term “mysticetes” refers to baleen whales; and the term “cetaceans” is inclusive of odontocetes and mysticetes.

There are 38 species of marine mammals, including 6 mysticetes, 28 odontocetes, and 4 seals, known to inhabit the Northwest Atlantic OCS Region (BOEM 2014b). For the purposes of the analysis in this FEIS, the focus is on species and life stages of 15 (of the 38 considered [Table 3.4-2]) marine mammals that would be likely to have regular or common occurrences in the proposed OECC and WDA, which is based on the area defined by Kenney and Vigness-Raposa (2010). The time of year, level of activity, and duration of construction, operation, and decommissioning activities were important factors in determining which marine mammal species would likely be present at the time and place of the various activities associated with offshore wind development on the Atlantic OCS. Furthermore, species occurrence and density data were used to identify the subset of marine mammals for consideration and to estimate the distributions of those species. Among marine mammal species that may occur in this area, five are listed as endangered: North Atlantic right whale (NARW, *Eubalaena glacialis*), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). Table 3.4-2 depicts the 15 marine mammals considered likely to occur regularly or commonly in the OECC and WDA. Data regarding the occurrence of marine mammals were collected by vessel, aerial, and acoustic survey methods. For these marine mammal species identified as having a regular or common occurrence in the OECC and WDA, specific descriptions and information are provided about data collection, marine mammal siting and stranding events, density data, and current conditions and trends associated with marine mammal occurrence. However, because sightings and strandings data indicate that blue whales occur along the U.S. East Coast only occasionally (NMFS 1998; Kraus et al. 2016b), blue whales are expected to be rare in the OECC and WDA. The co-occurrence of blue whales and Project vessels in deep water vessel transit areas is unexpected, and the use of speed reductions and lookouts for all marine mammals result in any effects to blue whales being extremely unlikely to occur. Therefore, potential impacts on blue whales from the Project are not expected to occur, and this species is not considered further in this FEIS. Beaked whales can occur in relatively high numbers in the Northwest Atlantic OCS Region; however, this occurrence is usually offshore near the shelf edge (BOEM 2014b) outside of the OECC and WDA, and they are not considered further in this FEIS. Finally, details (e.g., biology, population status, life history, habitats, the threats they face, distribution, and conservation efforts) for the species that may be impacted by offshore wind development on the Atlantic OCS can be found in the BO issued by NMFS (2020), the COP (Volume III, Table 6.7-1; Epsilon 2020b), and through the following resources:

- NMFS Find a Species website at https://www.fisheries.noaa.gov/find-species
- The Northeast Ocean Data Portal at https://www.northeastoceandata.org/data-explorer/?mammals-turtles
- Ocean Biogeographic Information System–Spatial Ecological Analysis of Megavertebrate Populations species profiles at http://seamap.env.duke.edu/
- NOAA Cetacean Density and Distribution Mapping Working Group at https://mgel.env.duke.edu/projects/noaa-cetacean-density-and-distribution-mapping-working-group/

Marine mammals utilize the coastal waters of the northwest Atlantic OCS for a variety of biologically important functions such as resting, foraging, mating, avoiding predators, and migration (Madsen et al. 2006; Weilgart 2007). Seasonal migration between foraging and nursery grounds determines the biogeography of marine mammals in the Northwest Atlantic. The availability and abundance of prey items, which is itself influenced by regional oceanographic conditions, determines these movement patterns. The mixing in the Gulf of Maine of cold, fresh Scotian Shelf water and warm, saltier slope water that enters the Gulf via the Northeast Channel forms the main water mass affecting the New England Shelf. Water temperatures at a depth of 112 feet (34 meters) near the proposed WDA varied between 35 and 75°F (2 and 24°C) from October 2009 to July 2010 (Ullman and Codiga 2010). These conditions affect zooplankton abundance and distribution.

Some marine mammals are highly migratory, and seasonal occurrences in the proposed OECC and WDA vary for each species. The BO issued by NMFS includes distribution maps of the ESA-listed species and details regarding their seasonal occurrence (NMFS 2020b). Seasonal distributions for non-listed marine mammals, including humpback whales *(Megaptera novaeangliae)*, minke whales *(Balaenoptera acutorostrata)*, harbor porpoise (*Phocoena phocoena*), and three dolphin species in the OECC and WDA area are shown in Appendix E, Figures E.5-1 through E.5-4. The distribution maps present species occurrence using a combination of habitat-based density estimates that represents a compilation of data from various sources (Roberts et al. 2016a, 2016b) and sightings data overlaid as density dots (circles representing the number of animals sighted over the time period; Right Whale Consortium 2018). These datasets provide a comprehensive assessment of distribution based on available data. Many of the same data sources are included in both databases, but not all. For example, the density estimates are based on data collected from 1992 to 2018, while the sightings data were collected from 1978 to 2019. The density estimates represent the predicted unweighted mean number of animals predicted to occur per 10 km^2. The sightings data are an historical account of the number of marine mammals that have been observed in a particular area, and do not account for the presence (or absence) of marine mammals in areas not surveyed. BOEM did not correct these sightings data for effort and they are represented as different colors with different density scales for each species, and thus should not be used to interpret the relative densities of marine mammals.

The habitat within the proposed OECC and WDA provides foraging habitat and may play a role in the reproductive cycle for multiple species (Leiter et al. 2017; Stone et al. 2017). Stone et al. (2017) documented 27 sightings of cetaceans with their young, including humpback whales, fin, sei, minke, NARWs, pilot whales, common bottlenose dolphins *(Tursiops truncatus),* and common dolphins *(Delphinus delphis)*. Humpback whales had the highest number of sightings with calves present (ten). Calves were present in all seasons from October 2011 through June 2015, but a majority of these observations were during spring and summer (81.5 percent). NARWs were observed engaging in mating/courtship behavior and foraging, and mothers with calves were sighted in recent surveys in the waters around the RI and MA Lease Areas (Leiter et al. 2017; Stone et al. 2017). The BO provides detailed discussions regarding documented behaviors of listed species (NMFS 2020b). Results from these studies and others indicate that the habitat within the vicinity of the WDA has a higher ecological significance than previously known (Stone et al. 2017). A total of 669 cetacean sightings, including 384 large whale sightings, were recorded within the waters around the RI and MA Lease Areas during systematic line-transect aerial surveys between October 2011 and June 2015 (Kraus et al. 2016b; Stone et al. 2017; Table 3.4-3). The area encompassing the waters around the RI and MA Lease Areas was also surveyed using aerial and acoustic surveys from 2010 through 2017 as part of the Atlantic Marine Assessment Program for Protected Species (Palka et al. 2017).These data are included in the abundance and sightings maps of humpback whales, minke whales, harbor porpoise, Atlantic white-sided dolphins

(Lagenorhynchus acutus), common bottlenose dolphins, and short-beaked common dolphins by season (Figures E.5 1 through E.5-4 in Appendix E).

The primary prey source for baleen whales generally, including NARWs specifically, is zooplankton. Seasonal trends in overall zooplankton abundance have been detected over the shelf waters of southern New England, ranging from relatively low densities (12 to 23 cubic centimeters per 100 cubic meters) in January through February to relatively high densities (greater than 55 cubic centimeters per 100 cubic meter) during May through August (NEFSC 2018b). These trends are also present in one of the most abundant and widespread zooplankton species on the Northeast U.S. Shelf, *Calanus finmarchicus*, an important food source for many fish species and for NARWs. On average, *C. finmarchicus* has been the most abundant during the spring and summer (March through August), with the peak density in May through June along the Northeast U.S. Shelf (NEFSC 2018b). Levels of zooplankton biovolume have been remarkably consistent over the past 20 years with some inter-annual variability. However, mean total density for *C. finmarchicus* along the Northeast U.S. Shelf varied greatly from year to year, commonly halving or doubling from one year to the next (NEFSC 2018b). The BO discusses recent trends in the abundance and distribution of this important food source for NARWs (NMFS 2020b). This region also has a very diverse and abundant fish assemblage that includes prey species for marine mammals, including American Sand Lance (*Ammodytes americanus*), Atlantic Herring (*Clupea harengus)*, and Atlantic Mackerel (*Scomber scombrus*).

Over the last several years, NARW distribution and patterns of habitat use have shifted, in some cases dramatically (Pettis et al. 2017). Elevated NARW mortalities have occurred since June 7, 2017. A total of 31 confirmed dead stranded whales, with an additional 10 live free-swimming whales with serious injuries due to entanglement or vessel strike, have been documented to date (NOAA 2020b). Human interactions (e.g., fishery-related entanglements and vessel strikes) are the most likely cause of this unusual mortality event (UME). In addition to this recent UME, the reproductive output for the species has declined by 40 percent since 2010 (Kraus et al. 2016b). Recent evidence suggests that the proportion of NARW mortality attributed to fishing gear entanglement and overall mortality is likely higher than previously estimated (Pace et al. 2021). In 2018, no new NARW calves were documented in their calving grounds, but at least ten new calves have been documented so far during the 2019–2020 calving season, up from seven in the 2018–2019 calving season (Pettis et al. 2021). This combination of factors threatens the very survival of this species (Pettis et al. 2017). A more detailed discussion of the current status of the NARW is available in the BO (NMFS 2020b).

Fin whales are very common over the continental shelf waters from Cape Hatteras, North Carolina, northwards (Hayes et al. 2020) and are present in every season throughout the U.S. Exclusive Economic Zone (EEZ) north of Cape Hatteras (Edwards et al. 2015). They are typically found along the 328-foot (100-meter) isobath but also in shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1986). Fin whales are migratory, moving seasonally into and out of feeding areas, but the overall migration pattern is complex and specific routes are not known (NMFS 2018a). The species occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. Thus, their movements overall are patterned and consistent, but distribution of individuals in a given year may vary according to their energetic and reproductive condition, and climatic factors (NMFS 2010). Fin whales in U.S. waters belong to the Western North Atlantic stock. The best abundance estimate available for this stock is 7,418 individuals (Hayes et al. 2020). For 2013 through 2017, the minimum annual rate of human-caused (i.e., vessel strike and entanglement in fishery gear) mortality and serious injury was 2.35 per year (Hayes et al. 2020). There are insufficient data to determine the population trend for fin whales (Hayes et al. 2020).

The Nova Scotia stock of sei whales is distributed across the continental shelf waters from the northeast U.S. coast northward to south of Newfoundland (Hayes et al. 2020). This species is highly mobile, and there is no indication that any population remains in a particular area year-round (NMFS 2011). Sei whale occurrence in a particular feeding ground is considered unpredictable or irregular (Schilling et al. 1992) but may be correlated to incursions of relatively warm waters of the Irminger Current off West Greenland (NMFS 2011). Olsen et al. (2009) also indicated that sei whales' movements appear to be associated with oceanic fronts, sea surface temperatures, and specific bathymetric features. NMFS (2011) indicated that climate change may negatively impact sei whale habitat availability and food availability, as migration, feeding, and breeding locations may be affected by ocean currents and water temperature. Sei whales occurring in the U.S. Atlantic EEZ belong to the Nova Scotia stock. The best abundance estimate for this stock is 6,292, though this estimate must be considered uncertain due to the uncertainties around population structure and whale movements as well as the fact that not all of the known range of this stock was surveyed. (Hayes et al. 2020). Between 2013 and 2017, the average annual minimum human-caused mortality and serious injury was 1.0 sei whales per year (Hayes et al. 2020). Threats to sei whales include vessel strike and entanglement in fisheries gear. No population trend is available for this stock.

Sperm whales are widely distributed throughout the deep waters of the North Atlantic. Distribution along the U.S. east coast is centered along the shelf break and over the slope (CETAP 1982). An exception to this distribution pattern is found in the shallow continental shelf waters of southern New England, where relatively high numbers of sightings have been reported, particularly between late spring and autumn (Scott and Sadove 1997). Geographic distribution of sperm whales appears to be linked to social structure. The stock structure of the Atlantic population of sperm whales is poorly understood. It is not clear whether the western North Atlantic population is discrete from the eastern North Atlantic population (Hayes et al. 2020). However, the portion of the population found within the U.S. EEZ likely belongs to a larger stock in the western North Atlantic. Sperm whales are listed under the ESA as the global population, with the best available estimate of 300,000 to 450,000 whales (NMFS 2015). Estimates from selected regions of sperm whale habitat exist for some time periods; however, there is no current reliable estimate of total sperm whale abundance for the entire North Atlantic. Sightings have been almost exclusively in the continental shelf edge and continental slope areas, but little or no survey effort has been conducted beyond the continental slope. The best recent abundance estimate for sperm whales is the sum of the 2016 surveys—4,349 (Hayes et al. 2020). There have been no documented reports of human-caused mortality or serious injury to this stock in the EEZ from 2013 to 2017. The status of this stock relative to optimum sustainable population in the U.S. Atlantic EEZ is unknown and there are insufficient data to determine population trends (Hayes et al. 2020).

Data through 2015 indicated that the trend for the Gulf of Maine stock of the humpback whale, which is considered part of the West Indies DPS, was increasing. However, since January 2016, strandings of humpback whales in the Western North Atlantic have occurred at a higher than normal rate. This event has been declared a UME and may be related to larger-than-usual numbers of vessel collisions (NOAA 2019c). There have been 131 mortalities documented from Maine to Florida through April 17, 2019, as part of this event (NOAA 2020a), with 29 animals found off Massachusetts and Rhode Island. Stranding location is not necessarily indicative of the location of injury or death, as floating carcasses can move with tide and currents. Of all the whales examined, about 50 percent had evidence of either ship strike or entanglement (NOAA 2019c). Although the stock is currently characterized by an upward trend in abundance, the detected level of U.S. fishery-caused mortality and serious injury, which is likely biased low, is more than 10 percent of the calculated potential biological removal,[5] and therefore cannot be considered insignificant (Hayes et al. 2020). Since January 2017, elevated minke whale mortalities have occurred along the Atlantic coast from Maine through South Carolina, with 43 total strandings documented as of July 31, 2018 (including 13 strandings in Massachusetts; NOAA 2018a). These mortalities have been declared a UME.

The U.S. population size of the Western North Atlantic stock of gray seals *(Halichoerus grypus)* is estimated at 27,131 (Hayes et al. 2020). For the period 2013 to 2017, the average estimated human-caused mortality and serious injury to gray seals across the entire North Atlantic Stock (including both United States and Canada) was 5,410 per year (Hayes et al. 2020). The western North Atlantic stocks of gray, hooded, harbor, and harp seals *(Pagophilus groenlandicus)* all experience human-caused mortalities each year (Table 3.4-4; Hayes et al. 2020, Waring et al. 2007). Mortalities caused by human interactions with seals may result from boat strikes, fishing gear interactions, power plant entrainment, oil spill/exposures, harassment, shooting, and research. For the period from 2013 to 2017, more gray and harp seal strandings were reported in Massachusetts than in any other state from Maine to North Carolina (Hayes et al. 2020). In this same region, hooded seal strandings during 2001 to 2005 were also higher in Massachusetts than in any other state. From Maine to North Carolina during 2011 to 2015, the most stranding mortalities were in Massachusetts (348 animals), which is the center of gray seal abundance in U.S. waters, and this species has the lowest overall stock abundance of the four seals that are found in the region (Hayes et al. 2020; Waring et al. 2007). The Western North Atlantic stock of harbor seals *(Phoca vitulina)* is estimated at 75,834 animals, with an estimated human-caused mortality and serious injury of 350 seals per year from 2013 to 2017 (Hayes et al. 2020). During 2013 to 2017 from Maine to North Carolina, the second highest number of harbor seal

[5] Calculated potential biological removal is the maximum number of animals, not including in natural mortalities, which may disappear annually from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population level.

strandings (367 animals) was recorded off Massachusetts (Hayes et al. 2020). The current abundance estimate for hooded seals belonging to the Western North Atlantic stock is 512,000, with an estimated human-caused mortality and serious injury of 5,199 animals per year (Waring et al. 2007). Among strandings from Maine to North Carolina from 2001 to 2005, the highest number of hooded seals was recorded off Massachusetts (53 animals; Waring et al. 2007). The abundance estimate for the Western North Atlantic stock of harp seals is 7.4 million animals, with an estimated human-caused mortality and serious injury rate of 232,422 seals per year (Hayes et al. 2020). From 2013 to 2017 from Maine to North Carolina, the highest number of strandings (83 animals) was recorded off Massachusetts (Hayes et al. 2020). NMFS defines a strategic marine mammal stock as a declining stock that is experiencing a high level of human-caused mortality and is likely to be listed under the ESA or designated as depleted under the MMPA. None of these seal stocks are considered strategic.

In the North Atlantic, common dolphins are found over the continental shelf between the 328- and 6,562-foot (100- and 2,000–meter) isobaths and east to the mid-Atlantic Ridge (Hayes et al. 2018), but may be found in shallower shelf waters as well. Common dolphins were the most frequently observed dolphin species in aerial surveys conducted from 2011–2015 in the Project area (Kraus et al. 2016a). Sightings peaked in the summer between June and August, although there were sightings recorded in nearly every month of the year (Kraus et al. 2016a). The coastal morphotype[6] of bottlenose dolphin is distributed primarily along the outer continental shelf and continental slope in the northwest Atlantic Ocean from Georges Bank to the Florida Keys and is the only type that may be present in the Project area. Bottlenose dolphins were the second most frequently observed species of dolphin in aerial surveys conducted from 2011–2015 in the Project area and were observed in every month of the year except January and March (Kraus et al. 2016a). Risso's dolphins (*Grampus griseus*) are distributed off the northeastern U.S. coast along the continental shelf edge from Cape Hatteras northward to Georges Bank during spring, summer, and autumn (CETAP 1982; Payne et al. 1984 as referenced in NMFS' Proposed Incidental Harassment Authorization [84 FR 18346]). Common dolphins are not expected to be common in the Project area due to the relatively shallow water depths. In aerial surveys conducted from 2011–2015 in the Project there were only two confirmed sightings of Risso's dolphins, both of which occurred in the spring (Kraus et al. 2016a).

Marine mammals in the geographic analysis area are subject to a variety of ongoing human-caused impacts, including collisions with vessels (ship strikes), whaling/hunting, entanglement with fishing gear, fisheries by-catch, anthropogenic noise, pollution, disturbance of marine and coastal environments, effects on benthic habitat, accidental fuel leaks or spills, waste discharge, and climate change. Many marine mammal migrations cover long distances, and these factors can have impacts on individuals over broad geographical scales. Climate change has the potential to impact the distribution and abundance of marine mammal prey due to changing water temperatures, ocean currents, and increased acidity. The BO provides detailed discussions regarding these threats and other proposed Project-related threats to endangered marine mammals (BOEM 2019d; NMFS 2020b). Table 3.4-4 presents the current status for cetaceans in the OECC and WDA.

Commercial fisheries occurring in the southeastern New England region include bottom trawl, midwater trawl, dredge, gillnet, longline, and pots and traps (COP Volume III; Epsilon 2020b). Targeted fisheries species include monkfish, scallop, surfclam/quahog, squid, mackerel, herring, and lobster among others. Commercial vessel traffic in the region is variable depending on location and vessel type. The commercial vessel types and relative density in the Project region during 2013 include cargo (low), passenger (high), tug-tow (high), and tanker (low) (COP Volume III; Epsilon 2020b). Ambient noise measured within the wind lease area was between 76.4 and 78.3 decibels (dB) relative to 1 micropascal squared (μPa^2) (i.e., dB re 1 μPa^2) per hertz (Hz), with sources including commercial port traffic, recreational boats, and scientific and naval sonar activity (COP Volume III, Section 6.6.2.1.2; Epsilon 2020b) and reported to be between 96 dB and 103 dB (Kraus et al. 2016a).

Entanglement in fishing gear is a substantial ongoing threat to marine mammals. Fisheries interactions are likely to have demographic effects on marine mammal species, with estimated global mortality exceeding hundreds of thousands of individuals each year (Read et al. 2006; Reeves et al. 2013; Thomas et al. 2016). In the Atlantic, bycatch occurs in various gillnet and trawl fisheries in New England and the Mid-Atlantic Coast, with hotspots driven by marine mammal density and fishing intensity (Lewiston et al. 2014; NMFS 2018a). Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARWs and may be a limiting factor in

[6] Any of a group of different types of individuals of the same species in a population

the species recovery (Knowlton et al. 2012). Entanglement may also be responsible for high mortality rates in other large whale species (Read et al. 2006). Additionally, bottom trawling and benthic disruption have the potential to result in impacts on prey availability and distribution. These ongoing impacts on marine mammals would continue regardless of the offshore wind industry. However, as discussed below, the distribution of fishing effort may change due the presence of offshore wind facilities on the OCS.

3.4.1.1. Future Offshore Wind Activities (without Proposed Action)

BOEM expects future offshore wind development activities would affect marine mammals through the following primary IPFs.

Accidental releases: Accidental releases of fuel, fluids, hazmat, and/or trash and debris may increase as a result of future offshore wind activities. Section A.8.2 discusses the nature of releases anticipated. 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.

In the expanded planned action scenario (Table A-4 in Appendix A), there would be a low risk of a leak of fuel, fluids, and/or hazmat from any single one of approximately 2,021 WTGs, each with approximately 5,000 gallons (18,927 liters) stored. Total fuel, fluids, and/or hazmat within the geographic analysis area would be approximately 13.1 million gallons (49.6 million liters). 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 ESP, 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 ESPs 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 the 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). Additionally, accidental releases may result in impacts on marine mammals due to effects to prey species (Table 3.4-1). Based on the volumes potentially involved, the likely amount of additional releases associated with future 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. BOEM assumes operator compliance 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 WDAs. 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 track, disease, injury, and malnutrition (Baulch and Perry 2014). However, it is difficult to link physiological effects to 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 future 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. In the event of a release, it would be an accidental, low probability event in the vicinity of WDAs or the areas from ports to the WDAs used by vessels.

EMF: Marine mammals appear to have a detection threshold for magnetic intensity gradients (i.e., changes in magnetic field levels with distance) of 0.1 percent of the earth's magnetic field or about 0.05 microtesla (μT) (Kirschvink 1990) and are thus likely to be very sensitive to minor changes in magnetic fields (Walker et al. 2003). There is a potential for animals to react to local variations of the geomagnetic field caused by power cable EMFs. Depending on the magnitude and persistence of the confounding magnetic field, such an effect could cause a trivial temporary change in swim direction or a longer detour during the animal's migration (Gill et al. 2005). Such an effect on marine mammals is more likely to occur with direct current cables than with AC cables (Normandeau et al. 2011). In the expanded planned action scenario (Table A-4 in Appendix A), up to 5,947 miles (9,571 kilometers) of cable would be added in the geographic analysis area, producing EMF in the immediate vicinity of each cable during operations. Submarine power cables in the geographic analysis area are assumed to be installed with appropriate shielding and burial depth to reduce potential EMF resulting from cable operation to low levels. Marine mammals have the potential to react to submarine cable EMF; however, this impact, if any, would be limited to extremely small portions of the areas used by migrating marine mammals. As such, exposure to this IPF would be low; as a result, impacts such as changes in swimming direction and altered migration routes would not be expected to be biologically significant.

New cable emplacement and maintenance activities: The impact on water quality from sediment suspension during cable-laying activities is expected to be temporary and short-term. Using the assumptions in Table A-4 in Appendix A, the total area of seafloor disturbed by cable emplacement for offshore wind facilities is estimated to be up to 8,153 acres (33 km^2) beginning in 2022 and continuing through 2030. In addition to cables related to individual offshore wind facilities, two unsolicited proposals for the development of two open access offshore transmission systems have been announced. The routes for these proposed regional cables have not been determined at this time and are not considered reasonably foreseeable, but BOEM assumes that if future offshore wind projects utilize one of these open-access transmission systems, the impacts associated with new cable emplacement and maintenance activities would be less than if each individual project installed its own cable. Data are not available regarding marine mammal avoidance of localized turbidity plumes; however, Todd et al. (2015) suggest that since some marine mammals often live in turbid waters and some species of mysticetes employ feeding methods that create sediment plumes, some species of marine mammals have a tolerance for increased turbidity. Similarly, McConnell et al. (1999) documented movements and foraging of grey seals in the North Sea. One tracked individual was blind in both eyes, but otherwise healthy. Despite being blind, observed movements were typical of the other study individuals, indicating that visual cues are not essential for grey seal foraging and movement (McConnell et al. 1999). 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 short-term and temporary. Turbidity associated with increased sedimentation has some potential to result in temporary, short-term impacts on marine mammal prey species. While the cable routes for future offshore wind developments are unknown at this time, the areas subject to increased suspended sediments from simultaneous activities would be limited and all impacts would be localized and temporary. Sediment plumes would be present during construction for 1 to 6 hours at a time. Any dredging necessary prior to cable installation could also contribute additional impacts. Given that impacts would be temporary and generally localized to the emplacement corridor, no individual fitness or population-level effects on threatened or endangered marine mammals would be expected (NOAA 2020i). Similarly, the temporary and localized impacts associated with cable emplacement and maintenance activities are only expected to result in impacts ranging no response to short term and minor impacts on the behavior of non-threatened and endangered marine mammals. Based on the current anticipated construction schedule provided in Table A-6 in Appendix A, construction impacts associated with multiple projects could overlap in time and space and could potentially result in more frequent impacts, though no individual fitness or population-level impacts would be expected to occur. Threatened and endangered marine mammals do not appear to be affected by increased turbidity and would be expected to be able to successfully forage in adjacent areas not affected by sediment plumes (NOAA 2020i).

Noise: There are several intrinsic, extrinsic, and ecological drivers that can result in impacts on individuals and populations. Cetaceans rely heavily on acoustics for communication, foraging, mating, avoiding predators, and navigation (Madsen et al. 2006; Weilgart 2007). Offshore wind activities may negatively affect marine mammals if the sound frequencies produced overlap with the functional hearing range of the animal exposed (NSF and USGS 2011). Noise-producing activities may negatively affect marine mammals during foraging, orientation, migration, response to predators, social interactions, or other activities (Southall et al. 2007). Noise exposure can interfere with these functions, with the potential to cause responses ranging from mild behavioral changes to auditory injury. Since the potential effects of sound on marine mammal species potentially present in the WDA involves a complex analysis of the manner in which sound interacts with the physiology of marine mammals and the potential responses of those animals to sound,[7] only general information about sound and marine mammal hearing along with potential effects of sound on marine mammals is provided in this section. A summary of pile-driving noise exposure estimates are provided in Appendix F. These exposure estimates, in addition to the other acoustic impacts described below, may result in noise impacts on marine mammals. Understanding the existing acoustic habitat and frequency ranges marine mammals are able to hear described in this section was essential to the consideration of the effects of pile driving to marine mammals that is included in the exposure estimate shown in Appendix F and described in more detail in COP Appendix III-M (Pyć et al. 2018) and in the NMFS proposed IHA Federal Register notice planned to be issued under the MMPA.

3.4.1.1.1. Overview of Sound and Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals because they rely on sound to obtain detailed information about their surroundings, communicate, navigate, reproduce, socialize, and avoid predators. Thus, the surrounding soundscape is a key component of marine mammal habitat and can be considered their acoustic habitat (Clark et al. 2009). Underwater sound comes from numerous natural sources (biological and physical processes) and anthropogenic sources. Biological sounds include marine life (marine mammals, fish, snapping shrimp). Physical sounds include wind and wave activity, rain, cracking sea ice, undersea earthquakes, and volcano eruptions. Anthropogenic sound includes shipping and other vessel traffic, military activity, marine construction, oil and gas exploration and more. Some of these natural and anthropogenic sounds are present more or less everywhere in the ocean all of the time, therefore, background sound in the ocean is commonly referred to as “ambient noise” (DOSITS 2019a).

Sound travels in waves, the basic components of which make up frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in Hz or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the “loudness” of a sound and is typically described using the relative unit of the decibel. When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources), as is the case for sound produced by the pile-driving activity considered here. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and manmade sound receptors such as hydrophones. The sum of various natural and anthropogenic sound sources that comprise ambient noise at any given location and time depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor and is frequency-dependent. As a result of the dependence on numerous varying factors, ambient noise levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10 to 20 dB from day to day (Richardson et al. 1995). The result is that, depending on the source type and its intensity, sound from a specified activity may be a negligible addition to the local soundscape or could form a distinctive signal that may affect marine mammals.

The sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. In general, ambient sound levels tend to increase with increasing wind speed and wave height. Precipitation can be an important component of total sound at frequencies above 500 Hz and possibly down to 100 Hz during quiet times. Marine mammals can contribute significantly to ambient sound levels, as can some fish and snapping shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kilohertz (kHz). In deep water, low-frequency ambient sound from 1-10 Hz mainly comprises turbulent pressure fluctuations from

[7] For example, predicting how many marine mammals could be harassed required potential effects to be evaluated within the context of applicable laws and regulations. Both the MMPA and ESA require all anticipated responses to sound resulting from the proposed Project be considered relative to their potential impact on animal growth, survivability, and reproduction. Although a variety of effects may result from an acoustic exposure, not all effects would impact survivability or reproduction (e.g., short-term changes in respiration rate would have no effect on survivability or reproduction).

surface waves and the motion of water at the air-water interface. At these infrasonic frequencies, sound levels depend only slightly on wind speed. Between 20 and 300 Hz, distant ships transiting dominate wind-related sounds. Above 300 Hz, the ambient sound level depends on weather conditions, with wind- and wave-related effects mostly dominating the soundscape (NMFS 2018b). Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly. In the Vineyard Wind OECC and WDA, existing anthropogenic sources includes shipping and other vessel traffic, pile driving for various activities, geophysical surveys for research and other purposes, and military activity.

For frequency ranges marine mammals are able to hear, current data indicates not all marine mammal species have equal hearing capabilities (e.g., Richardson et al. 1995; Wartzok and Ketten 1999; Au and Hastings 2008). To reflect this, Southall et al. (2007, 2019) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (i.e., low-frequency cetaceans). Subsequently, NMFS (2018b) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 dB threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed biologically implausible and the lower bound from Southall et al. (2007) was retained. Marine mammal hearing groups and their associated hearing ranges are depicted in Table 3.4-5.

3.4.1.1.2. Overview of Potential Effects of Noise on Marine Mammals

Anthropogenic sounds cover a broad range of frequencies and sound levels, and thus can have a range of highly variable impacts on marine mammals, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In the following discussion, we first describe specific manifestations of acoustic effects before explanations specific to noise-producing Proposed Action activities. In these explanations, we refer to a review of several articles concerning studies of noise-induced hearing loss conducted from 1996 to 2015 (i.e., Finneran 2015). For study-specific citations, refer to that work. For the purposes of this analysis and the exposure estimate summarized in Appendix F and COP Appendix III-M (Pyć et al. 2018), impacts on marine mammals from anthropogenic sound are grouped as follows:

- ***Behavioral Effects:*** Behavioral responses to noise can range from minor to severe, depending on location, season, species, life-history stage, and type of noise. Some behavioral effects can include changes to or cessation of biologically important behaviors such as socializing, breeding, calving, feeding or resting; changes in diving behavior (e.g., reduced or prolonged dive times, increased time at the surface or number of blows per surfacing, changes in swimming speed or direction); reduced/ increased vocal activities; visible startle response and/or flight responses (e.g., pinnipeds flushing into water from haulouts or rookeries) or aggressive behavior (e.g., tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and changes in historical migration routes (NMFS 2018b; DOSITS 2019a). For example, several studies have observed cessation or changes in fin whale calls (Castellote et al. 2012; Cerchio et al. 2014) and in bowhead whale calls during their fall migration in the Alaskan Beaufort Sea, at distances of 26 to 28 miles (41 to 45 kilometers), when exposed to median received levels (SPL) of at least 116 dB re 1 μPa (Blackwell et al. 2015). In contrast, other studies documented increases in blue whale call production amidst received sound exposure levels of 131 dB re 1 μPa2-s, potentially indicating blue whales attempting to "compensate" for increases in background noise levels (Di Iorio and Clark 2010). Thus, available studies show wide variation in response to underwater sound and support how the degree of impact depends on many factors (e.g., behavioral state, reproductive state, distance to the sound source).
- ***Masking:*** Masking occurs when certain types of noise in the ocean interfere with an animal's ability to hear other important sounds. Masking is most likely to occur when a noise is at a similar frequency range as biologically important sounds, such as mating calls. Some cetaceans may respond to masking noise by changing their calls (e.g., call rate, frequency, loudness, or duration), or by changing their behavior (NMFS 2017).

- ***Physiological Effects:*** Based on existing studies, the physiological effects of noise on animals suggest temporary or permanent hearing loss, physiological responses associated with changes in normal diving behaviors, and other stress responses may occur (NMFS 2017). In general, marine mammals exposed to high-intensity sound or to lower-intensity sound for prolonged periods can experience hearing threshold shift or the loss of hearing sensitivities at certain frequencies (Nowacek et al. 2007; Finneran 2015). Threshold shift can be permanent (i.e., permanent threshold shift [PTS]), where the loss of hearing sensitivity is not fully recoverable, or temporary (i.e., temporary threshold shift [TTS]), in which case an individual's hearing threshold can recover with time (Southall et al. 2007). If PTS occurs, there is physical damage to sound receptors. For summaries of data on TTS in marine mammals or for further discussion of TTS onset thresholds, please see Southall et al. (2007), Finneran and Jenkins (2012), Finneran (2015), and 81 Fed. Reg. 66461 (September 27, 2016). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have been reviewed (e.g., Fair and Becker 2000; Romano et al. 2002b) and, more rarely, studied in wild populations (e.g., Romano et al. 2002a). For example, Rolland et al. (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in NARWs. These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors, and that it is possible that some of these would be classified as "distress." In addition, any animal experiencing TTS would likely also experience stress responses (NRC 2003).

Noise can be characterized as an extrinsic factor, which is a factor in an animal's external environment that creates stress in an animal (NASEM 2017). Anthropogenic noise on the OCS associated with the future offshore wind development, including noise from project aircraft, G&G surveys, vessel traffic, operational WTGs, and pile driving has the potential to result in impacts on marine mammals foraging, orientation, migration, predator detection, social interactions, or other activities (Southall et al. 2007).Future offshore wind development may require the use of helicopters to supplement crew transport during construction and operations. BOEM expects that helicopters transiting to the offshore WDAs would fly at altitudes above those that would cause behavioral responses from marine mammals except when flying low to inspect WTGs or take off and land on the service operations vessel (SOV). Noise associated with helicopter and/or aircraft use during construction and operations of future offshore wind development may result in some short-term and temporary non-biologically significant behavioral responses, including short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002). If a listed whale is located within 820 to 1,181 feet (250 to 360 meters) of the helicopter, it is possible that behavior responses may occur, but they are expected to be temporary and short-term. NARW approach regulations (50 C.F.R. § 222.32) prohibit approaches within 1,500 feet (457 meters). BOEM would require all aircraft operations to comply with current approach regulations for any sighted NARWs or unidentified large whale. While helicopter traffic may cause some temporary and short-term behavioral reactions in marine mammals while helicopters move to a safe distance, BOEM does not expect exposure to aircraft noise to result in injury to any marine mammals. Similarly, aircraft have the potential to disturb hauled out seals if aircraft overflights occur within 2,000 feet (610 meters) of a haul out area. However, this disturbance would be temporary and short-term, with individuals seeking refuge in the water for a few minutes to a few hours (Southall et al. 2007).

G&G noise resulting from offshore wind site characterization surveys is of less intensity and affects a much smaller area than the acoustic energy characterized by seismic airguns typically associated with oil and gas exploration. While seismic airguns are not used for offshore wind site characterization surveys, sub-bottom profiler technologies that are hull-mounted on survey vessels may have the potential to incidentally harass marine mammals and would be required to follow mitigation and monitoring measures. Typically, mitigation and monitoring measures are required by BOEM through requirements of lease stipulations and are prescribed by NMFS in ITAs pursuant to Section 101(a)(5) of the MMPA. Mitigation and monitoring measures are designed to minimize any potential impacts on marine mammals from exposure to active acoustic sources used during G&G surveys. Similarly, the requirement to comply with monitoring and minimization measures for these surveys would avoid any effects on individuals that could affect threatened and endangered populations listed under the ESA. These measures may include, but are not limited to, seasonal restrictions, protected species observers (PSOs), passive acoustic monitoring (PAM), pre-survey monitoring, and the establishment of exclusion zones in which sound sources would be shut down when marine mammals are present.

Noise associated with operational WTGs, while potentially audible to marine mammals, would not be expected to result in measurable impacts on individuals, as the SPLs generated by WTGs would be expected to be at or below ambient levels at a relatively short distance from WTG foundations (Kraus et al. 2016a; Thomsen et al. 2015). According to measurements at the Block Island Wind Farm, low frequency noise generated by turbines reaches ambient levels at 164 feet (50 meters; Miller and Potty 2017). SPL measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa root mean squared (RMS) at 46 and 65.6 feet (14 and 20 meters) from the WTGs (Tougaard et al. 2009). Although SPLs may be different in the local conditions of a WDA, if sound levels at the WDA are similar, operational noise could be slightly higher than ambient, which have equivalent continuous SPLs ranging from 96 to greater than 103 dB re 1µPa in the 70.8 to 224 Hz frequency band at the study area during 50 percent of the recording time between November 2011 and March 2015 (Kraus et al. 2016a). As such, little to no impacts on individual marine mammals would be expected to occur.

Vessel noise is the human activity that generates the greatest amount of sound energy into the ocean (Weilgart 2007). Vessel noise may result in multiple impacts for marine mammals, including reduced communication, interference with predator/prey detection, and avoidance of habitat areas (Southall 2005). Ship engines and vessel hulls themselves emit broadband, continuous sound, generally ranging from 150 to 180 dB re 1 µPa per meter, at frequencies below 1,000 Hz (NSF and USGS 2011).The frequency range for vessel noise falls within marine mammals' known range of hearing and would be audible. While vessel noise may have some effect on marine mammal behavior, it would be expected to be limited to temporary startle responses, masking of biologically relevant sounds, physiological stress, and behavioral changes (Erbe et al. 2018; Erbe et al. 2019; Nowacek et al. 2007). Studies indicate noise from shipping increases stress hormone levels in NARWs (Rolland et al. 2012), and modeling suggests that their communication space has been reduced substantially by anthropogenic noise (Hatch et al. 2012). The authors also suggest that physiological stress may contribute to suppressed immunity and reduced reproductive rates and fecundity in NARWs (Hatch et al. 2012; Rolland et al. 2012). Similar impacts could occur for other marine mammal species. Other behavioral responses to vessel noise could include animals avoiding the ensonified area, which may have been used as a forage, migratory, or socializing area. Results from studies on acoustic impacts from vessel noise on odontocetes indicate that small vessels at a speed of 5 knots in shallow coastal water can reduce the communication range for common bottlenose dolphins within 164 feet (50 meters) of the vessel by 26 percent (Jensen et al. 2009). Pilot whales in a quieter, deep-water habitat could experience a 50 percent reduction in communication range from a similar size boat and speed (Jensen et al. 2009). Since lower frequencies propagate farther away from the sound source compared to higher frequencies, low-frequency cetaceans are at a greater risk of exposure to noise from vessel traffic due to the frequencies associated with vessel traffic. Based on the vessel traffic generated by the proposed Project, it is assumed that construction of each individual offshore wind project (estimated to last 2 years per project) would generate an average of 25 and a maximum of 46 vessels operating in the geographic analysis area for marine mammals at any given time, although actual vessel trips would vary by project based on individual project designs and port locations. This increase in vessel traffic and associated noise impacts would be at its peak in 2022 to 2023, when at least five offshore wind projects (not including the Proposed Action) would be under simultaneous construction along the east coast—i.e., a total of approximately 125 to 230 vessels in the geographic analysis area at any given time during peak construction.[8] This increased offshore wind-related vessel traffic during construction, and associated noise impacts, could result in repeated localized, intermittent, short-term, impacts on marine mammals and result in brief behavioral responses that would be expected to dissipate once the vessel or the individual has left the area. These short-term and temporary responses are unlikely to be significant (Navy 2018). BOEM expects that these brief responses of individuals to passing vessels would be infrequent given the patchy distribution of marine mammals and that no stock or population-level effects would be expected. Further, as discussed in the BO, based upon the best available information, ESA listed mammals would not be expected to measurably respond to vessel noise in a way that would disrupt normal behavior patterns (NMFS 2020b).

Noise associated with cable laying would be produced during route identification, trenching, jet plow embedment, backfilling, and cable protection installation by vessels and equipment, with intensity and propagation dependent upon bathymetry, local seafloor characteristics, vessels, and equipment used (Taormina et al. 2018). Modeling using

[8] As specified in Section 1.2, BOEM's analysis of the reasonably foreseeable build-out scenario assumes that the potential challenges of vessel availability and supply chain will be overcome, and projects will advance as specified in the scenario.

in situ data collected during cable laying operations in Europe estimate that underwater noise would remain above 120 dB re 1 µPa in an area of 98,842 acres (400 km²) around the source (Bald et al. 2015; Nedwell and Howell 2004; Taormina et al. 2018). If cable-laying activities are assumed to occur 24 hours per day, the dynamic positioning (DP) vessel would continually move along the cable route over a 24-hour period, and the area within the 120 dB RMS isopleth would also be constantly moving over the same period. Thus, the estimated ensonified areas would not remain in the same location for more than a few hours and it is unlikely that the sound exposure related to cable-laying activities would result in adverse effects on marine mammals.

The following analysis assesses the impacts of pile-driving activities associated with offshore wind facilities on marine mammals under the expanded planned action scenario. The greatest potential for impact from noise exposure is likely to be caused by pile driving due to relatively high SPLs associated with this activity. The installation of WTG foundations into the seabed involves impact pile driving, which produces high SPLs in both the surrounding air and underwater environment. Sound levels may vary depending on the size of the hammer, diameter of the pile, properties of the seabed, and other environmental factors. This noise would be produced intermittently during construction of each project for approximately 2 to 3 hours per foundation or 4 to 6 hours per day for the installation of 2 foundations per day. Construction of offshore wind facilities is expected to occur intermittently over a 6- to 10-year period in lease areas that are anticipated to be developed on the Atlantic OCS. In the expanded planned action scenario (Table A-4 in Appendix A), construction of 2,066 offshore structures between 2022 and 2030 would result in temporary increases in noise that may impact marine mammals. Depending on their distribution in relation to construction activities and the timing of that construction, the duration and frequency of any exposure of marine mammals to construction noise would be variable. An individual may be exposed to anywhere from a single pile-driving event (lasting no more than a few hours on a single day), to intermittent noise over a period of weeks if an individual travels over the larger geographic analysis area where pile driving may be occurring. The potential effects of exposure to pile-driving noise range from minor, temporary behavioral disturbance to auditory injury. As explained above, the use of measures to mitigate exposure is expected to reduce the potential for injury and most individuals are expected to be exposed to noise levels that would result in recoverable auditory fatigue (i.e., TTS) and behavioral impacts. Some marine mammals may experience PTS; however, PTS is likely to be mild (e.g., small amount of threshold shift) and limited to the low-frequency bands associated with pile driving. The probability and extent of potential impacts are situational and are dependent on several factors including pile size, impact energy, duration, site characteristics (i.e., water depth, sediment type), time of year, and species, among others that have been considered in the acoustic exposure modeling.

Noise impacts on marine mammals arising from pile-driving activities could occur under three different scenarios (Table A-4 in Appendix A) that would affect the duration and frequency of exposure to pile-driving noise:

- Concurrent pile driving associated with neighboring projects (i.e., piles being driven at multiple projects on the same day within the same geographic regions of Massachusetts/Rhode Island, New York/New Jersey, Delaware/Maryland, or Virginia/North Carolina);
- Non-concurrent pile driving in the same year (i.e., piles being driven at multiple projects within the same year but not on the same day); and
- Consecutive, multi-year pile driving (concurrent or non-concurrent).

A limited amount of concurrent pile driving at neighboring projects is anticipated in the expanded planned action scenario. Concurrent pile driving could occur for one or more projects on the same day. Concurrent pile driving increases the daily amount of noise exposure in a broader area but decreases the total number of days of potential exposure from each project in the same area. Concurrent pile driving occurring within the same 24-hour period could extend the exposure period within a given day and may create a greater overall impact area(s) among neighboring projects in which marine mammals could be exposed to noise that may cause auditory or behavioral impacts. The number of foundations for each project is the primary factor determining the maximum number of overlapping pile-driving days from neighboring projects. One foundation per project installed per day results in the maximum-case scenario for the greatest number of overlapping pile-driving days for neighboring projects. The RI and MA Lease Areas have the greatest potential for concurrent pile driving to occur due to the number of projects that may have construction schedules overlapping with one another. The total number of possible concurrent construction days within the RI and MA Lease Areas ranges from 90 to 103 days under the one-pile-per-day scenario and 45 to 70 days of pile driving under the two-piles-per-day scenario, depending on the year (Table A-6).

It is important to note that this is a conservative estimate that reflects the maximum-case scenarios identified in PDEs and may overestimate the actual number of foundations installed for each project, and consequently overestimate the number of concurrent pile-driving days. The Delaware/Maryland Lease Areas have a potential for 11 or 6 days of concurrent pile driving in a year with multiple neighboring projects being constructed concurrently under the one-pile-per-day or two-piles-per-day scenarios, respectively. Marine mammal(s) present in either of these areas on those days could be exposed to the noise from more than one pile driving event per day, repeated over a period of days, dependent on the movement patterns of that animal. It is unlikely that individual marine mammals would be exposed to pile-driving noise generated on the same day from non-neighboring projects because of the distances between such projects and considering the distance and speed at which an individual would be expected to travel over the course of a day.

Non-concurrent pile driving in the same year could result in the exposure of marine mammals to pile-driving noise on multiple days in the same year depending on seasonal migratory behaviors, home ranges, and other factors. This exposure could occur periodically in different geographic areas over the course of the year. Non-concurrent pile driving potentially decreases the daily amount of noise exposure in a geographic area from neighboring projects but increases the total number of days of pile driving in the same area. A pile-driving scenario with project construction occurring on different days would result in the greatest number of days that an individual could be exposed to pile-driving noise. If project construction is timed to not overlap and occurs on separate days, the number of non-concurrent pile driving days in any given year is greater than the concurrent pile-driving scenario.

Pile driving for reasonably foreseeable projects is anticipated to occur over multiple years (2022 to 2030). Overall, a total of 1,956 or 979 non-concurrent pile-driving days under the one-pile-per-day or two-piles-per-day scenarios, respectively, may occur over this period under the maximum-case scenario, where an individual marine mammal could be exposed to pile driving in each geographic analysis area. Should concurrent pile driving occur over this period (2022–2030), a total of 343 or 172 concurrent pile-driving days would occur under the one-pile-per-day or two-piles-per-day scenarios, respectively, in the RI and MA and Delaware/Maryland Lease Areas. An additional 67 or 34 non-concurrent pile-driving days under the one-pile-per-day or two-piles-per-day scenarios, respectively, in the MA/RI and Delaware/Maryland Lease Areas would be required to complete construction of proposed projects. Although no concurrent pile driving is expected to occur in the remaining geographic areas (Maine, New York/New Jersey, and Virginia/North Carolina; see Table A-6), marine mammals could be intermittently exposed to pile-driving noise for up to 5 consecutive years from 2022 to 2026, from one or more projects, with additional potential exposure beyond 2030.

3.4.1.1.3. Marine Mammal Responses to Pile Driving

The population consequences of disturbance has gained recent attention in marine mammals, and most models have focused on odontocetes (Booth et al. 2014; Farmer, Baker, et al. 2018; Farmer, Noren, et al. 2018; King et al. 2015; Natural England 2017; Pirotta et al. 2015; NASEM 2017) and pinnipeds (Costa 2012; 2013; Noren et al. 2009). Only recently have some bioenergetic models for mysticetes been developed (Pirotta et al. 2019; Van der Hoop et al. 2016; Villegas-Amtmann et al. 2015). Not all adverse responses to noise are expected to result in a reduction in individual fitness levels. In many cases, responses to noise can be localized and temporary, and individuals can be assumed to resume normal functioning when exposure to the stressor ceases.

Harbor porpoises, one of the most behaviorally sensitive cetaceans, have received particular attention in European waters due to their protection under the European Union Habitats Directive (IAMMWG et al. 2015) and the threats they face because of fisheries bycatch. A study on the first German offshore wind farm showed that fewer porpoises were detected up to 12 miles (20 kilometers) from the pile-driving site and that the displacement period (up to 6 days) was positively correlated to the duration of the pile driving (Dähne et al. 2013). In an analysis of eight offshore wind facility projects, Brandt et al. (2016) found a clear gradient in the decline of porpoise detections at different distances to pile driving. Gradient effects showed that at 0 to 3.1 miles (0 to 5 kilometers) porpoise detections declined by about 68 percent; at 6.2 to 9.3 miles (10 to 15 kilometers), detections declined by about 26 percent, with no clear reduction in porpoise detections beyond 10.6 to 12.4 miles (17 to 20 kilometers). Following pile driving, porpoise detections increased 12 hours after pile driving at 12.4 miles (20 kilometers) and increased 20 to 31 hours after pile driving at closer distances up to 1.2 miles (2 kilometers). Little to no habituation was found, and there was no indication for the presence of temporal overall effects from construction of the eight wind facilities (Brandt et al.

2016). Scheidat et al. (2011) studied the effect on harbor porpoises over several years both before and after the installation of WTGs using acoustic data loggers placed on the seafloor both inside and outside the wind project. The study found a significant increase of 160 percent in the presence of porpoises 1 to 2 years after the wind facility was in normal operation compared to the baseline period (the construction period was not studied). This effect was linked to likely increases in food availability as well as the exclusion of fisheries and reduced vessel traffic in the wind project (Scheidat et al. 2011; Lindeboom et al. 2011).

Harbor seals have also been shown to have their behavior affected by pile-driving noise. A harbor seal telemetry study off the east coast of England found that seal abundance was reduced by 19 to 83 percent up to 15.5 miles (25 kilometers) during pile driving of WTG monopile foundations, but found no significant displacement resulted from construction overall as the seals' distribution was consistent with the non-piling scenario within 2 hours of cessation of pile driving (Russell et al. 2016) and they may increasingly use the foundations for foraging opportunities following installation of the subsea structures (Russell et al. 2016). Based on 2 years of monitoring at the Egmond aan Zee offshore wind project in the Dutch North Sea, satellite telemetry, while inconclusive, seemed to show that harbor seals avoided an area up to 24.8 miles (40 kilometers) from the construction site during pile driving, though the seals were documented inside the wind farm after construction ended, indicating any avoidance was temporary (Lindeboom et al. 2011). These findings are consistent with the best available information on noise and marine mammals which predicts a spectrum of effects depending on duration and intensity of exposure as well as species and behavior of the animal (e.g., migrating, foraging). BOEM expects that most animals would avoid areas with increased sound levels; however, if an animal does not leave the area, injury may occur.

Taken as a whole, the available literature suggests avoidance of pile driving at offshore wind projects has occurred in some instances, with the duration of avoidance varying greatly, indicating that marine mammal responses to pile driving in the offshore environment are unpredictable and are likely context-dependent. However, pile driving would occur in open ocean areas where marine mammals may freely move away from the sound source; therefore, BOEM does not anticipate situations where individual marine mammals would not be able to escape from disturbing levels of noise. Further, as noted above, minimization and mitigation measures would be implemented, which would reduce the severity of effects to individuals, which reduces the potential for impacts on populations.

For the projects considered under the expanded planned action scenario, the potential for any behavioral disturbance to be significant to the individual depends on several factors including the location of the pile(s) being driven, the behaviors being carried out by individuals (e.g., migrating, foraging) and the distribution of habitats that support those behaviors. For example, an animal that has its foraging activity disrupted by pile-driving noise would be expected to swim away from the noise source until it is far enough away that the noise is no longer at disturbing levels. If prey resources are adequate and available in the area that the animal is displaced to, the impact of that displacement may be limited just to the energy resources used for avoidance and any energetic costs of lost foraging opportunities, while an animal that is displaced to an area with forage that is absent or less abundant or available may experience a greater energetic cost. In general, the more frequently an animal has its normal behaviors disrupted and the longer the duration those disruptions are, the greater the potential for biologically significant consequences.

As noted above, BOEM assumes that future COP approvals will include project-specific mitigation and monitoring measures developed through NEPA, ESA consultations, and ITAs that will be implemented by each future project that will be designed to avoid exposure of individuals to injurious levels of noise and minimize and monitor effects of exposure that would result in behavioral responses. This may reduce the overall impacts on any individual by reducing project-specific impacts. The available literature suggests that individual marine mammals will avoid disturbing levels of noise by swimming away from the noise source, with the duration of avoidance varying greatly, indicating that marine mammal responses to pile driving in the offshore environment are unpredictable and likely context-dependent. The potential for biologically significant responses is expected to increase with increased exposure to multiple pile-driving events.

Port expansion/utilization: Increases in global shipping traffic and expected increases in port activity along the East Coast from Maine to Virginia will require port modifications to receive the increase in shipping traffic and increased ship size. However, future offshore wind development is expected to be a minor component of port expansion activities required to meet increased commercial, industrial, and recreational demand. The current bearing capacity of existing ports is considered suitable for wind turbines, requiring no port modifications for supporting offshore wind energy development (DOE 2014). Future channel deepening that may be necessary to accommodate larger ships required to carry offshore WTG components and/or increased vessel traffic associated with offshore wind projects may result in increased potential high intensity impacts including noise impacts, vessel strikes, and impacts on prey species, but exposure and risk would be expected to be localized to nearshore habitats. There are at least two proposed offshore wind projects that are contemplating port expansion/modification in Vineyard Haven and in Montauk. It is likely that other ports would be upgraded along the east coast, and some of this may be attributable to supporting the offshore wind industry. These port expansions would increase the total amount of disturbed benthic habitat, potentially resulting in impacts on marine mammal prey species. However, the expected disturbance of benthic habitat and the resulting impacts on marine mammals would likely be a small percentage of available benthic habitat overall. Increases in port utilization due to other offshore wind energy projects will lead to increases in vessel traffic. This increase will be at its peak during construction activities and will decrease during operations but will increase again during decommissioning. In addition, any related port expansion and construction activities related to the additional offshore wind projects would add to increased turbidity in the coastal waters.

Presence of structures: The presence of structures can lead to impacts, both beneficial and adverse, on marine mammals through localized changes to hydrodynamic disturbance, prey aggregation, and associated increase in foraging opportunities, entanglement and gear loss/damage, migration disturbances, and displacement. These impacts may arise from buoys, met towers, foundations, scour/cable protections, and transmission cable infrastructure during any stage of a project. Using the assumptions in Table A-4 in Appendix A, the expanded planned action scenario would include up to 2,066 foundations, 2,944 acres (12 km^2) of new scour protection, and hard protection atop cables. Projects may also install more buoys and met towers. BOEM anticipates that structures would be added intermittently over an assumed 6- to 10-year period beginning in 2022, and that they would remain until decommissioning of each facility is complete (30 years).

Manmade structures, especially tall vertical structures such as WTG and ESP foundations, alter local water flow at a fine scale, and could potentially result in localized impacts on marine mammal prey distribution and abundance (Section 3.3.1.1). Water flow typically returns to background levels within a relatively short distance from the structure. Tank tests, such as the one conducted by Miles et al. (2017), conclude that mean flows are reduced immediately downstream of a monopile foundation, but return to background levels within a distance proportional to the pile diameter (D). For foundations like those proposed by Vineyard Wind, background conditions would return approximately 328 feet (100 meters) away from each monopile foundation. Hydrodynamic disturbance can increase seabed scour and sediment suspension around foundations, but BMPs would be in place to minimize scour; therefore, sediment plumes, if any, would return to baseline conditions within a short distance.

The changes in fluid flow caused by the presence of an estimated 2,066 structures could also influence marine mammals prey species at a broader spatial scale. The existing physical oceanographic conditions in the geographic analysis area, with a particular focus on the Southern New England region, are described in Appendix E. Although waters on the OCS experience considerable vertical mixing throughout much of the year, an important seasonal feature influencing marine mammal prey is the cold pool, a mass of cold bottom water in the mid-Atlantic bight overlain and surrounded by warmer water. The cold pool forms in late spring and persists through summer, gradually moving southwest, shrinking, and warming due to vertical mixing and other factors (Chen et al. 2018). During summer, local upwelling and local mixing of the cold pool with surface waters provides a source of nutrients, influencing primary productivity of the ecosystem, which in turn influences finfish and invertebrates (Lentz 2017; Matte and Waldhauer 1984). The presence of many wind turbine structures could affect oceanographic and atmospheric conditions by reducing wind-forced mixing of surface waters and increasing vertical mixing of water forced by currents flowing around foundations (Carpenter et al. 2016; Schultze et al. 2020). During times of stratification (summer), increased mixing due the presence of structures could possibly increase pelagic primary productivity in local areas (English et al. 2017; Kellison and Sedberry 1998). However, changes in primary productivity might not translate into effects on marine mammal prey species if the increased productivity is consumed by filter feeders, such as mussels, that colonize the surface of the structures (Slavik et al. 2019). The ultimate effects on marine mammal prey species, and therefore marine mammals, of changes to oceanographic and atmospheric conditions caused by the presence of offshore structures are not known at this time, and they are likely to vary seasonally and regionally.

The presence of new structures could result in a localized increase prey items for some marine mammal species at individual WTG foundations. Individual WTG and ESP foundations could increase the mixing of surface waters and deepen the thermocline, possibly increasing pelagic productivity in local areas (English et al. 2017; Kellison and Sedberry 1998). However, the overall effect of the large number of structures may result in reduced mixing that could potentially overwhelm any localized effects due to individual monopiles. Additionally, hard-bottom (scour control and rock mattresses used to bury required offshore export cables) and vertical structures (i.e., WTG and ESP foundations) in a soft-bottom habitat can create artificial reefs, thus inducing the “reef effect” that is associated with higher densities and biomass of fish and decapod crustaceans (Causon and Gill 2018; Taormina et al. 2018). Invertebrate and fish assemblages may develop around these reef-like elements within the first year or two after construction (English et al. 2017). Although some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the reef effect results in increased productivity versus simply attracting and aggregating fish from the surrounding areas (Causon and Gill 2018). Recent studies have found increased biomass for benthic fish and invertebrates, and possibly for pelagic fish, marine mammals, and birds as well (Raoux et al. 2017; Pezy et al. 2018; Wang et al. 2019), indicating that offshore wind farms can generate beneficial permanent impacts on local ecosystems, translating to increased foraging opportunities for marine mammal species (Section 3.3.1.1). Current data that suggest seals (Russell et al. 2014) and harbor porpoises (Scheidat et al. 2011) may be attracted to the future offshore wind development infrastructure. Since seals and harbor porpoise occur in the geographic analysis area, it is likely that these species would be attracted to the forage items including shellfish and other fish species and shelter provided within individual WDAs. As such, some marine mammals (e.g., seals and small odontocetes), would be expected to use habitat in between the WTGs as well as around structures for feeding, resting, and migrating. The vertical WTG structures may also result in increased benthic productivity, potentially increasing prey availability for some marine mammal species at individual monopile locations, relative to surrounding locations (English et al. 2017). However, the overall impacts associated with the large number of monopiles may reduce overall mixing and overwhelm local benefits at individual WTG foundations.

While there is some uncertainty as described above, the anticipated reef effect would be expected to result in beneficial effects to several groups of marine mammals due to increased prey availability. However, some potential for increased exposure to high intensity risk of interactions with fishing gear that may lead to entanglement, ingestion, injury, and death exists. The presence of structures may concentrate recreational fishing around foundations, both personal and for-hire, and would also increase the risk of gear loss/damage by entanglement, potentially increasing the risk of entanglement in both lines and nets and increasing the risk of injury and mortality due to infection, starvation, or drowning (Moore and van de Hoop 2012). Additionally, commercial and recreational fishing vessels may be displaced outside of the WDAs. The expanded planned action scenario would impact all fisheries and all gear types (Section 3.10). Bottom tending mobile gear is more likely to be displaced than fixed gear. The future offshore wind projects would be more likely to displace larger fishing vessels with small mesh bottom-trawl gear and mid-water trawl gear, compared to smaller fishing vessels with similar gear types that may be easier to maneuver. In addition to displacement of fishing effort to areas outside of the WDA, some potential exists for a shift in gear types from fixed to mobile, or from mobile to fixed gear, due to displacement from the WDA. Although a potential for gear shift exists due to a change in the location of fishing effort, the potential impact to marine mammals is uncertain. However, if such a shift in gear types would occur, it may result in a potential increase in the number of vertical lines in the water column if there is no commensurate reduction in fixed gear types to mobile gear. In such circumstances of a greater shift of mobile gear to fixed 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. Fisheries interactions, including various gillnet and trawl fisheries in New England and the Mid-Atlantic Coast, are likely to have demographic effects on marine mammal species. 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) report 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 et al. 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 get tangled with foundations, reducing the chance that abandoned gear would cause additional harm to marine mammals and other wildlife, though 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 presence of structures and the anticipated reef effect have the potential to lead to increased recreational fishing within the lease areas and result in moderate exposure and high intensity risk of interactions with fishing gear that may lead to entanglement, ingestion, injury, and death (Moore and van der Hoop 2012). The reef effect may result in drawing in recreational fishing effort from inshore areas, and overall interaction between marine mammals and fisheries resulting from increased effort offshore could increase if marine mammals are also drawn to WDAs due to increased prey abundance. Fishing in and around foundations may increase marine debris from fouled fishing gear in the area. However, entanglement and ingestion of marine debris is not considered a new IPF but rather a change in the distribution of this factor if inshore fishing effort is moved offshore, with the potential for different species to be affected. Some level of displacement of marine mammals out of the lease areas into areas with a higher potential for interactions with ships or fishing gear during the construction phases of future offshore wind development may occur (Section 3.10). Additionally, some marine mammals may avoid the lease areas during all phases (construction, operations, and decommissioning) of the future offshore wind development. The presence of vertical WTG structures may interfere with echolocation behaviors exhibited by odontocetes whales as demonstrated at an offshore wind facility in Denmark (Teilmann and Carstensen 2012). While the proposed 1-nautical-mile spacing between WTGs would be sufficient to allow unimpeded movement within and between offshore wind facilities, there is a lack of information and a large amount of uncertainty relative to large whale responses to the presence of offshore WTG structures. Long-term intermittent impacts on foraging, migratory movements, or other important behaviors may occur as a result of the future offshore wind development. Additionally, temporary displacement from the WDAs during construction of projects into areas with higher risk of interactions with fishing and commercial vessels (see increased vessel traffic IPF below) may also contribute to impacts on marine mammals.

Increased vessel traffic: Vessel traffic associated with future offshore wind development poses a high-frequency, high-exposure, and collision risk to marine mammals, especially NARWs, other baleen whales, and calves that spend considerably more time at/near the ocean surface. Vessel strike is relatively common with cetaceans (Kraus et al. 2005) and one of the primary causes of death to NARWs with as many as 75 percent of known anthropogenic mortalities of NARWs likely resulting from collisions with large ships along the U.S. and Canadian eastern seaboard (Kite-Powell et al. 2007). Marine mammals are more vulnerable to vessel strike when they are within the draft of the vessel and when they are beneath the surface and not detectable by visual observers. Some conditions that make marine mammals less detectable include weather conditions with poor visibility (e.g., fog, rain, and wave height) or nighttime operations. Vessels operating at speeds exceeding 10 knots have been associated with the highest risk for vessel strikes of NARWs (Vanderlaan and Taggart 2007). Reported vessel collisions with whales show that serious injury rarely occurs at speeds below 10 knots (Laist et al. 2001). Data show that the probability of a vessel strike increases with the velocity of a vessel (Pace and Silber 2005; Vanderlaan and Taggart 2007). Offshore wind development will result in only a small incremental increase in vessel traffic volume relative to ongoing and future non-offshore activities, and no measurable overall impacts would be expected as result. Some level of overall effects can be expected should multiple projects be in the construction phase simultaneously. As described under the Noise section, at the peak of project construction from 2022 to 2023 up to 230 vessels associated with offshore wind development along the east coast may be operating in the geographic analysis area. This increase in vessel traffic would be added to the already very high existing vessel traffic in the greater southern New England area (NMFS 2020b). At this time, there is currently a high degree of uncertainty regarding the number of vessels, ports to be used, and primary transit routes that future offshore wind developments would use. Additional information regarding the expected increase in vessel traffic is provided in Section 3.11. The increase in vessel traffic associated with future offshore wind development has the potential to increase the risk of marine mammal/vessel interactions, which have been known to cause serious injury and occasional mortality in large whales (Berman-Kowalewski et al. 2010; Douglas et al. 2008; Laggner 2009; Lammers et al. 2003; NMFS 2020b). Collision risk would only be expected when Project vessels are transiting to and from the WDAs. Once in the WDAs, vessels would be stationary during construction activities and no collision risk would be expected. Additionally, vessels transiting from WTG foundation locations would do so at lower speeds than when transiting from ports to the WDA. While BMPs and mitigation measures required by BOEM and NMFS may avoid or reduce the likelihood of fatal vessel interactions, increased potential interactions would be expected in lease areas, with greatest impact potential occurring during construction activities when vessel traffic volumes would be the greatest, though some increased risk would also be expected during operations and decommissioning as well. This increased collision risk has the potential to result in injury or mortality to individuals. The relative risk of vessel strikes from wind industry vessels is dependent upon the stage of development, time of year, number of vessels, and speed of vessels during each stage.

Temporary and/or permanent increases in vessel traffic outside of lease areas may also occur due to displacement of commercial and recreational fishing vessels. Bottom tending mobile gear is more likely to be displaced form the WDAs than fixed gear. The expanded planned action impact scenario would be more likely to displace larger fishing vessels with small mesh bottom-trawl gear and mid-water trawl gear, compared to smaller fishing vessels with similar gear types that may be easier to maneuver. More information regarding the potential for displacement of fishing vessels is provided in Section 3.10. Displacement of these vessels and gear types may lead to increased interactions with marine mammals that are also temporarily or permanently displaced out of the lease areas.

Climate change: Several IPFs related to climate change, including increased storm severity and frequency, increased erosion and sediment deposition, increased disease frequency, ocean acidification, as well as altered habitat, ecology, and migration patterns, have the potential to result in impacts on marine mammals. These long-term, high consequence impacts could include increased energetic costs associated with altered migration routes, reduction of suitable breeding and/or foraging habitat, and reduced individual fitness, particularly juveniles. However, future offshore wind development would not be expected to contribute to climate change impacts on marine mammals. Section A.8.1 details the expected contribution of offshore wind activities to climate change.

3.4.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, marine mammals would continue to follow current regional trends and respond to current and future environmental and societal activities.

While the proposed Project would not be built as proposed under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind activities, and future offshore wind activities to have continuing temporary to permanent impacts (disturbance, displacement, injury, mortality, and reduced reproductive and foraging success) on marine mammals, primarily through pile-driving noise, vessel noise, presence of structures, vessel traffic, commercial and recreational fisheries gear interactions, and climate change. BOEM anticipates that impacts from ongoing activities, especially vessel traffic and noise, as well as fisheries gear interactions would be **moderate**. In addition to ongoing activities, reasonably foreseeable activities other than offshore wind may also contribute to impacts on marine mammals. Reasonably foreseeable activities other than offshore wind include increasing vessel traffic, new submarine cable and pipeline installation and maintenance, marine surveys, marine minerals extraction, port expansion, channel deepening activities, military readiness activities, and the installation of new towers, buoys, and piers (Table 3.4-1). BOEM anticipates that the impacts of reasonably foreseeable activities other than offshore wind would be **moderate**. BOEM expects the combination of ongoing activities and reasonably foreseeable activities other than offshore wind to result in **moderate** impacts on marine mammals, primarily driven by ongoing noise impacts and interaction with commercial and recreational fisheries gear.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area would result in **moderate** adverse impacts because of the presence of structures and pile-driving noise and increased vessel traffic. Additionally, the presence of structures could potentially result in **minor beneficial** impacts on some marine mammal species. The majority of offshore structures in the geographic analysis area for marine mammals would be attributable to the offshore wind industry. The offshore wind industry would also be responsible for a majority of the impacts associated with new cable emplacement and EMF, but effects to marine mammals resulting from these IPFs would be localized and temporary, and would not be expected to be biologically significant. The offshore wind industry would be responsible for a majority of the impacts associated with pile-driving noise, which could lead to moderate impacts to marine mammals in the geographic analysis area. However, overall, these impacts would not be expected to result in stock or population level impacts.

The No Action Alternative would forgo the long-term PAM, vessel strike reporting, and pile-driving monitoring that Vineyard Wind has committed to, or would be required to perform, the results of which could provide an understanding of the effects of offshore wind development, benefit future management of these resources, and inform planning of other offshore developments. BOEM acknowledges, however, that other ongoing and future monitoring and surveys could provide similar data to support similar goals.

3.4.2. Consequences of Alternative A

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on marine mammals:

- The WTG foundation type used. The potential acoustic impacts on marine mammals differ among the WTG foundation types that Vineyard Wind would use: either 100 monopiles (34 foot-diameter [10.3-meter]) and up to two ESP jacket foundations (Scenario 1) or a combination of 90 monopiles and up to 12 jacket foundations (Scenario 2). Although monopile foundations have a higher source level than jacket-type piles, more jacket-type piles would be installed per day (up to four 9.8-foot [3-meter] pin piles per jacket), increasing the risk of PTS to marine mammals (Pyć et al. 2018). Consequently, cumulative sound exposure levels are higher for marine mammals under Scenario 2 than under the Scenario 1 (Pyć et al. 2018).
- Sound produced by pile driving. To assess daily underwater sound produced by pile driving, sound from each pile type would be analyzed independently due to differences in source levels produced by the hammer power needed to drive each pile type, daily pile-driving duration for each foundation type, and the frequency spectrum produced by each pile diameter. Depending on the species' hearing differences and pile differences, the relative impacts on each hearing group vary considerably, warranting a separate analysis for each pile type.
- Total days of pile driving. At the installation rate of one monopile or jacket foundation per day, Vineyard Wind would need a total of 102 days of pile driving regardless of whether they use Scenario 1 or Scenario 2 (Pyć et al. 2018). At two monopiles and one jacket foundation installed per day, only 52 days of pile driving would be needed for Scenario 1 and 57 days of pile driving for Scenario 2. In terms of total days of pile driving, the maximum-case scenario would be 102 days of work (Pyć et al. 2018).
- Vessels and ports. Vineyard Wind would utilize a number of ports during proposed-Project activities. Section 2.1.1 provides more details.
- Mitigation and monitoring measures. In instances where the implementation of a mitigation or monitoring measure could have a measurable reduction in the level of the stressor of a potential effect, that measure would be considered in the level of impact in the analysis.

Aspects of the proposed-Project design include the OECC, the WTG design selected (e.g., 8 MW, 14 MW), the exact placement and number of WTGs and ESPs, the final inter-array cable layout, and the construction schedule, which would be determined based on site assessment data, engineering requirements, and other factors. Although some variation is expected in the design parameters, the impact assessment in this section analyzes the maximum-case scenario.

Alternative A alone would likely result in temporary to permanent impacts (disturbance, displacement, injury, mortality) that are expected to be generally localized and range from **negligible** to **moderate**, and could potentially include **minor beneficial** impacts to some marine mammals species due to prey aggregations around structures.

The analysis of impacts under the No Action Alternative, and references therein, applies to the following discussion of the Proposed Action. The most impactful IPFs associated with the Proposed Action would likely include pile-driving noise, which could cause noticeable temporary impacts for 4 to 6 hours per day during construction; increased vessel traffic, which could lead to injury and/or mortality; and the presence of structures, which would lead to permanent impacts that may be either adverse or beneficial. Other IPFs would likely contribute impacts of lesser intensity and extent, and would occur primarily during construction, but also during operations and decommissioning (Table 3.4-1). For additional details, see Table 3.4-1.

In context of reasonably foreseeable environmental trends, impacts of the Proposed Action in addition to ongoing activities, future non-offshore wind activities, and future offshore wind activities are listed by IPF in Table 3.4-1. Under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind activities, and future offshore wind activities other than the proposed Project to have continuing temporary to permanent impacts on marine mammals across the range of IPFs, primarily through the following IPFs: G&G survey noise, pile-driving noise, presence of structures, vessel traffic, and climate change.

In context of reasonably foreseeable environmental trends, the combined impacts of ongoing and planned actions, including Alternative A, would be of the similar types described in Section 3.4.1, but may differ in intensity and extent.

All marine mammals in the United States are protected under the MMPA, and some species receive additional protection under the ESA. Within the framework of the MMPA, a marine mammal "stock" is defined as "a group of marine mammals of the same species or smaller subspecies in a common spatial arrangement that interbreed when mature" (16 U.S.C. § 1362). NMFS published a Notice of Proposed IHA on April 30, 2019, in the Federal Register for the incidental taking of marine mammals during construction of the Project (84 Fed. Reg. 18346 [April 30, 2019]). The IHA requires mitigation, monitoring, and reporting measures that are incorporated into the integrated mitigations in this FEIS (Appendix D). A summary of these measures includes, but are not limited to, seasonal and time-of-day restrictions, establishment of clearance and monitoring zones, clearance and monitoring protocols, enhanced measures for NARWs, soft start and shut-down measures, sound reduction, vessel speed restrictions, and reporting conditions.

The ESA provides for listing species, subspecies, or DPSs of species, all of which are referred to as "species" under the ESA. The Interagency Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the ESA (61 Fed. Reg. 4722 [February 7, 1996]) defines a DPS as "any subspecies of fish or wildlife or plants, and any DPS of any species of vertebrate fish or wildlife which interbreeds when mature." If a population meets the criteria to be identified as a DPS, it is eligible for listing under the ESA as a separate species (81 Fed. Reg. 66461 [September 27, 2016]). However, MMPA stocks do not necessarily coincide with DPSs under ESA (81 Fed. Reg. 62660–62320 [September 8, 2016]). BOEM is acting as the lead federal agency for purposes of Section 7 consultation; the other action agencies include the Bureau of Safety and Environmental Enforcement, the USACE, the U.S. Environmental Protection Agency (USEPA), the USCG, and the NMFS's Office of Protected Resources. Consultation on threatened and endangered species concluded with issuance of a BO on September 11, 2020 (NMFS 2020b). The BO concluded that the Proposed Action may adversely affect but is not likely to jeopardize the continued existence of fin whale, sei whale, sperm whale, and NARWs, nor affect any designated critical habitat. Additionally, the Vineyard Wind 1 Project is not likely to adversely affect blue whales. In addition to the mitigation, monitoring, and reporting measures that will be required in the final IHA for listed marine mammals, Reasonable and Prudent Measures and implementing Terms and Conditions of the BO are required that include, but are not limited to, exclusion zone and monitoring conditions for NARWs during pile driving, increased monitoring when a Dynamic Management Areas or Slow Speed Zone is designated, mitigation actions required during PAM detections, time of day and weather restrictions, and reporting requirements.

Accidental releases: The incremental impacts of the Proposed Action from accidental releases of hazmat and trash/debris would not increase the risk beyond that described under the No Action Alternative. Further, the Proposed Action would comply with the USCG requirements for the prevention and control of oil and fuel spills and would implement proposed BMPs for waste management and mitigation as well as marine debris awareness training for Vineyard Wind 1 Project personnel, reducing the likelihood of an accidental release. In the unlikely event of an accidental oil spill, oil may negatively impact marine mammals within 20 to 50 miles (32 to 80 kilometers) of the spill. BOEM expects the negative impacts to be sublethal due to quick dispersion, evaporation, and emulsification, which would limit the amount and duration of exposure of marine mammals to hydrocarbons. Vineyard Wind would have an Oil Spill Response Plan in place that would decrease potential impacts from spills. Therefore, due to the unlikelihood of an oil spill, the sublethal level of impact, and the implementation of an Oil Spill Response Plan, potential temporary negative impacts on marine mammals from accidental releases of fuel, fluid, hazmat, trash or debris would result in **negligible** impacts, if any, due to the rare, brief, and highly localized nature of accidental releases.

While the significance level of impacts would remain the same, BOEM could further reduce impacts to help alleviate potential mortality and injury with the following mitigation measures conditioned as part of the COP approval (Appendix D): provide Project personnel with informational training on proper storage and disposal practices to reduce the likelihood of accidental discharges.

In context of reasonably foreseeable environmental trends, combined impacts of accidental releases on marine mammals from ongoing and planned actions, including Alternative A, are expected to be temporary and highly localized due to the likely limited extent and duration of a release, resulting in **negligible** impacts. The contribution from future offshore wind, including Alternative A, would be a low percentage of the overall accidental release risk from ongoing activities.

EMF: Both OECC and inter-array cable arrays are AC, and Vineyard Wind would bury these cables at a depth of 5 to 8 feet (1.5 to 2.5 meters). Modeled and measured magnetic field levels from various existing submarine power cables indicate that AC cables buried to a depth of 3 feet (1 meter) would emit field intensities less than 0.05 μT up to 82 feet (25 meters) above the cable, and 79 feet (24 meters) along the seafloor. While EMF associated with the proposed Project's submerged cables would be detectable by marine mammals, non-measurable-**negligible** impacts, if any, would be expected due to the localized nature of EMF along the cables near the sea floor, the wide ranges of marine mammals, and appropriate shielding and burial depth. EMF from multiple cables would not overlap even for multiple cables within a single OECC.

In context of reasonably foreseeable environmental trends, the combined impacts of EMF on marine mammals from ongoing and planned actions, including Alternative A, are expected to be long-term but highly localized, resulting in overall **negligible** impacts.

New cable emplacement and maintenance activities: The Proposed Action's incremental contribution of up to 328 acres (1.3 km^2) of seafloor disturbance by cable installation and up to 69 acres (0.3 km^2) affected by dredging prior to cable installation would result in turbidity effects that have the potential to have temporary impacts on some marine mammal prey species (Sections 3.2.2 and 3.3.2). Model results of simulations show that the use of the trailing suction hopper dredge for pre-cable installation dredging on the OECC has the potential to generate temporary turbidity plumes throughout the entire water column of TSS at 10 mg/L extending up to 9.9 miles (16 kilometers) and 750 mg/L extending up to 3.1 miles (5 kilometers) from the OECC centerline for 2 to 3 hours respectively, though this may be less extensive at varying locations along the route (COP, Volume III, Appendix III-A; Epsilon 2020b).

Relatively high TSS concentrations (>1,000 mg/L) are predicted at distances up to 3.1 miles (5 kilometers) from the OECC centerline in response to the relatively high loading of dumping and swift transport of the dumped sediments, but this high concentration would only persist for less than 2 hours. In general, excess TSS concentrations over 10 mg/L from dredging could extend several kilometers from the OECC centerline and may be present throughout the entire water column, but such concentrations are temporary and typically dissipate within about 6 hours (COP Volume III, Appendix III-A; Epsilon 2020b). Elevated turbidity levels would be short-term and temporary, and marine mammals reside often in turbid waters, so significant impacts from turbidity are not likely (Todd et al. 2015). Sediment dispersal model results indicate that during inter-array cable-laying activities most of the mass settles out quickly and is not transported for long by the currents (COP Volume III, Appendix III-A; Epsilon 2020b). The sediment plume is confined to the bottom 9.8 feet (3 meters) of the water column, which is only a fraction of the total water column in the WDA. Deposition greater than 0.04 inch (1 millimeter) is confined within 328 feet to 492 feet (100 meters to 150 meters) of the trench centerline for the typical and maximum-impact simulations respectively, and maximum deposition in both simulations is less than 0.2 inch (5 millimeters). Therefore, BOEM anticipates short-term and localized water quality impacts from inter-array cable installation and undetectable **negligible** impacts on marine mammals from turbidity. Based on the assumptions in Table A-6 in Appendix A, only the South Fork Wind Project (OCS-A 0486) cable laying would overlap in time with the Proposed Action cable laying (2021 to 2022). However, given the localized nature of these impacts, impacts associated with the emplacement of South Fork Wind's export and inter-array cabling would not overlap spatially with the Proposed Action and no impacts would be expected. 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 also 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** impacts, if any, on individuals would be expected given the localized and temporary nature of the potential impacts.

In context of reasonably foreseeable environmental trends, the combined cable emplacement impacts on marine mammals from ongoing and planned actions, including Alternative A, are expected to be **negligible**. Some non-measurable **negligible** impacts could occur if impacts occur in close temporal and spatial proximity, though these impacts would not be expected to be biologically significant.

Noise: The various types of **negligible to moderate** impacts on marine mammals due to anthropogenic noise associated with the incremental impacts of Alternative A alone would not increase the impacts of noise beyond the impacts described under the No Action Alternative.

BOEM expects that helicopters transiting to the WDA would fly at altitudes above those that would cause behavioral responses from marine mammals except when flying low to inspect WTGs or to take off and land on the SOV. While helicopter traffic may cause some short-term behavioral reactions in marine mammals, BOEM expects these impacts to be short-term, temporary, and **negligible,** resulting in minimal energy expenditure.

Marine mammals would be able to hear the continuous underwater noise of operational WTGs. However, based on the results from Thomsen et al. (2015) and Kraus et al. (2016a), the received SPLs generated by the Project turbines are expected to be at or below ambient levels at relatively short distances (164 feet [50 meters]) from the foundations (Miller and Potty 2017). SPL measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa at 46 and 65.6 feet (14 and 20 meters) from the WTGs (Tougaard et al. 2009). Although SPLs may be different in the local conditions of the WDA, if sound levels are similar, operational noise could be slightly higher than ambient, which ranged from 95 to greater than 104 dB re 1 µPa in the waters near the RI and MA Lease Areas from 2011 to 2015 (Kraus et al. 2016a). Based on the results from both Tougaard et al. (2009) and Kraus et al. (2016a), the operational sounds generated by WTGs associated with the Proposed Action are expected to be similar to the ambient sounds found in the waters around the RI and MA Lease Areas (Pyć et al. 2018). Given that WTG noise would reach the background ambient sound levels within a short distance from WTG bases, non-measurable **negligible** impacts to marine mammals, if any would be expected to occur.

There is a potential risk of noise impacts on marine mammals from pile-driving activities for the proposed Vineyard Wind 1 Project due to the large radial distance to PTS and behavioral harassment thresholds over the maximum total of 102 days that pile driving may occur. Vineyard Wind has committed to implement measures, including soft start, a noise attenuation system, PSOs, and PAM, which are designed to reduce the potential impacts on marine mammals.[9] Further, no pile driving would occur during the peak season of NARW occurrence in the WDA (between January 1 and April 30); therefore, impacts on this species would be completely avoided during this time, as no pile driving would occur. Additional detail on the voluntary measures Vineyard Wind has committed to are described in detail in Pyć et al. 2018 and Appendix D. Additional measures that must be applied to the proposed Project, including mandatory terms and conditions and reasonable and prudent measures to minimize the extent or amount of incidental take of endangered species, are included as part of the Incidental Take Statement included with the BO issued by the NMFS (2020). General conditions and mitigation, monitoring, and reporting measures relative to marine mammals provided in the IHA, if issued, are also discussed in detail in Appendix D. Overall, the modeled predicted exposure rates indicate that impacts would be expected to be **negligible**, for mid- and high-frequency cetaceans and pinnipeds for both potential injury and behavior disruption because of the small number of individuals of any species that would be exposed to pile-driving noise and that any auditory injuries would be minor and any behavioral disruption would be temporary and intermittent. In this group, only the sperm whale is endangered; no injury or mortality of any sperm whales is anticipated and effects would be limited to temporary behavioral disruptions of a very small number of individuals. For low-frequency cetaceans, under the maximum-case scenario, the modeled predicted risk of non-lethal auditory injury was low without sound attenuation or aversion used in the modeled scenarios (Pýc 2018). Based on the analysis, BOEM considers impacts from pile driving to be **minor** for NARW due to avoidance of peak seasons of occurrence and the extensive mitigation and monitoring measures that are specific to the species. While some NARW-specific mitigation and monitoring measures outlined in Appendix D would provide some protections to other species, BOEM considers impacts from pile driving to be **moderate** for all other marine mammals in the low frequency hearing group. Pile-driving activities would be conducted in accordance with the BO (NMFS 2020b), IHA, and all measures provided in Appendix D that would require the use of PSOs, PAM, monitoring zones, and other mitigation and monitoring measures to minimize impacts on marine mammals.

Based on the current anticipated construction schedule in Table A-6 in Appendix A, Revolution Wind and Sunrise Wind may conduct pile-driving activities within the same year and region as the proposed Project. The South Fork Wind Project proposes to install up to 16 foundations, which are anticipated to be installed prior to pile-driving activities associated with the Vineyard Wind 1 Project (Table A-6 in Appendix A).

At this time, it is assumed that future offshore wind projects would install one to two WTGs foundations per day. Revolution Wind could potentially install up to 90 WTG foundations, requiring 45 to -90 pile -driving days under

[9] While Vineyard Wind has committed to voluntarily implement some mitigation and monitoring measures, some of those measures as well as others would be required by NMFS in the Project BO and IHA issued for the proposed Project.

the two-piles and one-pile-per-day scenarios, respectively, that could occur concurrent with the proposed Project. Sunrise Wind could potentially install 112 WTG foundations, requiring 56 to 112 pile-driving days under the two-piles and one-pile-per-day scenarios, respectively, that could occur concurrent with the proposed Project. Considering the potential for all three of these projects to be constructed in the same year, overlap of these three projects in 2023, 51 to 102 days of concurrent pile driving (either two or three projects installing WTG foundations on the same day) under the two-piles and one-pile-per-day scenarios, respectively, could occur (Table 3.4-6). Based on the documented seasonal distribution of NARW in the geographic area where these projects are proposed and the critically endangered status of this species, it is anticipated that pile driving for the Revolution Wind and Sunrise projects will follow a similar time-of-year restriction planned for the proposed Project (May 1 through December 31). Under these expected seasonal restrictions for other projects, there would be 244 days of available pile driving each year. To complete the required number of WTG foundation installations with the least amount of concurrent pile-driving days, 214 days would be required with one pile per day. The remaining piles for the three projects could be installed over 30 days in the expected pile-driving window at three piles per day across the three projects. Under the one-pile-per-day scenario, pile driving could occur over more days, but the duration of impacts each day is short (1 to 3) hours, and ensonified areas are limited to a single project area during a majority of the pile-driving window.

As discussed in Pyć et al. (2018), the modeled radial distance for harassment of low-frequency cetaceans from installation of a 33.8-foot [10.3-meter)] pile with 6 dB attenuation is approximately 2.56 miles [4.12 kilometers]. Recently completed modeling for the South Fork Wind Project, using different parameters (a 36.1-foot [11-meter] pile with 6 dB attenuation during winter), hammer type, hammer energy, and environmental conditions resulted in a radial distance of approximately 4.63 miles (7.45 kilometers) for harassment of low-frequency cetaceans. Given that the modeled South Fork radial distance is larger, to be conservative, this larger distance was applied to the Revolution and Sunrise projects for which complete modeling is not yet available, and BOEM assumes represents the maximum-case scenario. If all three projects (Vineyard Wind 1, Revolution Wind, and Sunrise Wind) are constructed concurrently, a total of 90 days of concurrent pile-driving days could occur under a three-piles-per-day scenario (one pile per day for each project). Under this maximum-case scenario, three areas with diameters of 5.12, 9.26, and 9.26 miles (8.24, 14.90, and 14.90 kilometers) for Vineyard Wind 1, Revolution Wind, and Sunrise Wind, respectively, could have increased underwater noise that could be result in behavioral disturbance to marine mammals present in those areas. However, pile driving would not occur if marine mammals are observed within clearance zones prior to initiation of pile-driving activities, and many marine mammals would be expected to avoid those areas with increased sound levels once pile driving commences. This is considered very conservative because it is expected that noise attenuation greater than 6 dB, assumed to be required by agency permit conditions, would be achieved for piles driven for all three projects; therefore, actual isopleth distances corresponding to relevant harassment thresholds are expected to be less than those described above. Given the distance between lease areas, there is no potential for overlapping areas ensonified above relevant thresholds; however, underwater noise from multiple projects could intermittently be heard by animals traveling through the area. In addition to the 90 days that concurrent pile driving could potentially occur for all three projects, an additional 12 days of concurrent pile driving could potentially occur on two projects (Vineyard Wind 1 and Sunrise Wind) to complete construction of Vineyard Wind 1. Under the most conservative potential scenarios with only 6 dB of attenuation achieved, the resulting impact areas for these two projects would have diameters of 5.12 miles (8.24 kilometers) (Vineyard Wind) and 9.26 miles (14.90 kilometers) (Sunrise Wind). Again, noise isopleths would not overlap, but may occur concurrently in the RI and MA Lease Areas. Finally, under the most conservative scenario, 10 pile-driving days would be required to complete construction of the Revolution Wind Project. This scenario represents the maximum-case scenario for the total area impacted when pile driving occurs concurrently, as the modeling assumed that only 6 dB of sound attenuation can be achieved and the unlikely scenario that impact pile driving would be occurring at the exact same time. Given the short duration of any particular pile driving event, the size of the area surrounding each pile where potentially disturbing levels of noise will be experienced, and the inclusion of mitigation measures designed to minimize exposure of marine mammals generally and NARW specifically, to pile-driving noise, consideration of multiple pile-driving events in the same year does not change the conclusions reached.

BOEM estimates that pile driving could be expected to occur between 2 to 6 hours per day (two foundations per day) for each project, resulting in up to 18 hours per day if conducted independently and up to 6 hours per day if conducted simultaneously. With the potential restriction on commencing pile driving to 1 hour after sunrise and 1.5

hours before sunset, it is anticipated that pile driving could potentially occur between 9.5 to 12 hours each day between May 1 and December 31. The foraging potential of an individual marine mammal may be decreased during exposure to pile-driving noise. However, actual lost foraging potential is dependent on the behavior of the animal at the time of exposure (e.g., resting, socializing, foraging, etc.), the availability and quality of the forage in a particular area, the duration of the disturbance, and ability to resume foraging in the area where an animal was displaced. Given the anticipated distribution and movement patterns of individual whales over the period of time that pile driving is anticipated, the same individual whales are not expected to be disturbed over the entire duration of pile-driving activities. Take estimates of marine mammals during the course of construction of the proposed Project will be provided in the IHA if issued by NOAA (see Tables F.1-7 through F.1-9 in Appendix F).

According to the NRA (COP Volume III, Appendix III-I; Epsilon 2020b), current vessel traffic in the OECC, WDA, and surrounding waters is relatively high, and vessel traffic within the Vineyard Wind lease area is relatively moderate. The NRA for the OECC and WDA indicates that the maximum number of vessels during construction would be 46 per day (with an average of 25 per day) (COP Volume III, Appendix III-I; Epsilon 2020b). This volume of traffic would vary monthly depending on weather and Proposed Action activities. Over the course of the entire construction phase, the Proposed Action would generate an average of seven daily vessel trips between both the primary and secondary ports and the WDA. During the period of maximum activity, Proposed Action construction would generate an average of 18 construction vessel trips per day in or out of construction ports. In maximum conditions, this could theoretically include up to 46 trips in a single day—including up to 4 trips per day to or from secondary ports, with the remainder originating or terminating at the MCT, compared to the current 25 daily vessel trips measured via AIS in 2011 (COP Volume III, Appendix III-I; Epsilon 2020b). Vineyard Wind would use vessels with ducted propeller thrusters during construction and installation activities. Of the 19 different Proposed Action vessel types listed in COP Table 4.2-1 (Volume I, Section 4.2.4; Epsilon 2020a) all except three—barge, floating crane, and smaller support vessels that use jet-drive propulsion—are described as having "blade propeller system/blade thrusters." Assuming sound sources for blade propeller system/blade thrusters are similar to those for ducted propellers, vessel noise may cause behavioral modification for some marine mammals. Sound-source levels for ducted propeller thrusters were modeled for a project offshore of Virginia (BOEM 2015b) and measured during the installation of the Block Island Wind Farm transmission cable. For both projects, the sound-source level was 177 dB RMS at 3 feet (1 meter). Ducted propeller thruster use may exceed threshold criteria for injury at a distance of 351 feet (107 meters) (BOEM 2014b). However, marine mammals would need to remain within that distance for a prolonged period to be impacted by PTS, which is extremely unlikely to occur. Distances to the threshold criteria for behavioral modification for marine mammals would be approximately 0.9 to 2 miles (1.4 to 3.2 kilometers). Potential behavioral impacts on marine mammals from Proposed Action-related vessel traffic noise would be intermittent and temporary as animals and vessels pass near each other. During construction, impacts are anticipated to be **moderate** for all mysticetes because the lower frequency of sound emitted from vessels overlaps in the most sensitive hearing range of mysticetes and may affect mysticetes over larger areas compared to the other marine mammals. However, these impacts would be temporary, limited to construction months within the OECC and WDA, and are not expected to have stock or population-level effects. Further, as defined in Table 3.1 in Appendix B, populations would be expected to fully recover once the IPF is removed and no ESA take of marine mammals would be expected to occur as a result of vessel presence and noise (NMFS 2020b) Potential temporary behavioral impacts on all other marine mammals from vessel traffic are expected to be **minor,** with marine mammal populations fully recovering following construction of the proposed Project.

Cable laying noise associated with the Proposed Action may also affect marine mammals. The timeframe for offshore export cable installation is still being developed in response to time-of-year considerations, but it is likely that offshore export cable installation would occur in the period April through October. If offshore export cable installation occurs in April, it is possible that NARW would be feeding in the vicinity of the OECC. However, all appropriate mitigation measures would be implemented to minimize potential impacts, including the 1,640-foot (500-meter) setback (COP Addendum, Section 1.2.4; Epsilon 2019a). The cumulative sound exposure level over 24 hours (L_{E24}) during cable laying is expected to reach approximately 237 dB re 1 μPa^{2}s at 1 meter (3.3 feet) (Xodus Group 2015), which exceeds the NMFS threshold criteria for PTS from non-impulsive noise (L_{E24} 199 dB re 1 x; Pyć et al. 2018). The distance to the threshold for Level A Harassment is expected to be relatively small (Xodus Group 2015) and the distance to threshold for Level B Harassment is expected to be in the range of other vessel noise. BOEM therefore anticipates **minor** temporary impacts from cable laying noise, with marine mammal populations fully recovering following cable installation.

While the significance level of impacts would remain the same, BOEM could further reduce impacts to help alleviate potential impacts on marine mammals with the following mitigation measures conditioned as part of the COP approval (Appendix D) by BOEM that also includes the mitigation, monitoring, and reporting requirements proposed by Vineyard Wind, the reasonable and prudent measures required in the September 11, 2020, Incidental Take Statement (ITS) issued by NMFS under the ESA (NMFS 2020b), and the conditions required in the final IHA to be issued by NMFS under the MMPA. The mandatory measures included in the ITS to NMFS' September 11, 2020, BO have been designed to reduce the amount and extent of take of ESA-listed marine mammals and sea turtles related to pile-driving noise and the amount or extent of take of sea turtles due to vessel strike (NMFS 2020b). The use of noise-reduction technologies during all pile-driving activities to ensure a minimum attenuation of 6 dB would reduce the area impacted by noise during construction. The specific technologies have not yet been selected; potential options include a Noise Mitigation System, Hydro-sound Damper, Noise Abatement System, a bubble curtain, or similar (Pyć et al. 2018). In addition to the use of one sound attenuation system, Vineyard Wind has committed to complete sound field verification and to have a second attenuation technology on hand, which would be deployed if sound field verification demonstrates a need for greater attenuation. The use of PSOs during pile driving and high-resolution geophysical (HRG) survey activities would reduce the potential noise impacts by establishing and maintaining exclusion zones to minimize marine mammal exposure to injurious levels of noise. The detectability of marine mammals is dependent upon meteorological conditions, PSO training, PSO fatigue, animal behavior, and vocalization rates (relevant for PAM). PSO training and shift requirements, as detailed in Appendix D, will increase the ability of PSOs to detect listed species. Vineyard Wind will also submit an alternative monitoring plan to ensure the ability to maintain exclusion zones during adverse visibility conditions. Further, PAM will provide an additional means of detecting vocalizing marine mammals that are not visible at the surface.

- Use long-term PAM buoys or autonomous PAM devices.
- Implement pile-driving noise reduction technologies to achieve a reduction of noise.
- Implement a Pile Driving Monitoring Plan.
- Monitor pile-driving noise to ensure compliance with required noise reductions and consistency with modeled noise attenuation estimates.
- Enlarge exclusion zones based on field measurements, if necessary, to reduce risk of exposure of marine mammals to injurious levels of noise.
- Conduct daily preconstruction surveys to ensure that marine mammals and sea turtles are not present in the area during pile driving.
- Use a real-time PAM system to monitor for NARW presence.
- Use PSOs to establish and maintain marine mammal clearance zones prior to and during pile-driving activities.
- Implement pile-driving time-of-year restrictions to avoid pile driving during the time of year with the greatest potential risk to NARW.
- Implement pile driving time-of-day restrictions to ensure adequate visibility during required monitoring of clearance zones.
- Implement shut-down and power-down procedures when marine mammals are detected in the exclusion zone.
- Implement enhanced time-of-year shut-down and restart procedures.
- Conduct daily and weekly reporting of marine mammals observed, if any, during pile-driving operations
- Use PSOs on Project vessels to enhance detection of marine mammals and reduce risk of vessel strike.

Decommissioning impacts include underwater noise emitted from underwater acetylene cutting torches, mechanical cutting, high-pressure water jet, and vacuum pump. SPLs are not available for these types of equipment, but are not expected to be higher than construction vessel noise (generally between 150 and up to 180 dB re 1 µPa [Pangerc et al. 2016]). Vineyard Wind would return the sediments previously removed from the inner space of the pile to the depression left after the pile is removed. In addition, Vineyard Wind would likely use a vacuum pump and diver or ROV-assisted hoses to minimize sediment disturbance and turbidity. Vineyard Wind may abandon the offshore export cables in place to minimize environmental impact, in which case there would be no impacts from their decommissioning. If required, Vineyard Wind would remove the cables from their embedded position in the seabed.

Where necessary, Vineyard Wind would jet plow the cable trench to remove the sandy sediments covering the cables and reel the cables onto barges. Risks from removing the cables would be short-term, localized to the Proposed Action area, and similar to those experienced during cable installation. Although some of the decommissioning activities (e.g., acoustic impacts and increased levels of turbidity) may cause marine mammals, including listed species, to avoid or leave the Proposed Action area, this disturbance would be short term and temporary. The increased vessel traffic associated with decommissioning could also cause a temporary increase in potential effects. Details regarding potential impacts on listed species are found in the BA (BOEM 2018b). BOEM anticipates **minor** temporary impacts on marine mammals, with populations fully recovering following decommissioning.

In context of reasonably foreseeable environmental trends, the combined impacts due to various anthropogenic noise sources on marine mammals from ongoing and planned actions, including Alternative A, are expected to range from **negligible** to **moderate**. When all of the acoustic stressors described above and in Table 3.4-1 are assessed, they are all likely to contribute in underwater sound levels that could cause behavioral harassment or injury to some individual marine mammals in the geographic analysis area. Additionally, the intermittent exposure but persistent elevation in ambient noise across the geographic analysis area could produce physiological stress on individuals, to which the Proposed Action would contribute. Sounds from many of these sources travel over long distances, and it is possible that some would overlap in time and space with sounds from pile driving or other noise associated with the Proposed Action, in particular distant shipping noise, which is more widespread and continuous. It is not known whether the co-occurrence of shipping noise, geophysical surveys associated with renewable energy site characterization, military training, and sounds associated with pile driving would result in harmful additive impacts on marine mammals. However, these activities are widely dispersed, the sound sources are intermittent, and mitigation measures would be implemented to reduce acoustic disturbance from pile driving to reduce any potential combined exposure to elevated underwater sound levels of concern. The temporary to permanent noise impacts associated with Alternative A, when combined with past, present, and reasonably foreseeable activities would be expected to range from and **negligible** to **moderate**. The temporary **moderate** impacts on low-frequency cetaceans that would be expected to result from the pile driving of offshore wind projects would be added to existing noise levels beginning in 2021 and continuing through 2030 along the east coast. The IPF would be removed from the environment once pile driving is completed for the offshore wind projects, and behavior of marine mammals is expected to return to normal. However, the effects of PTS may be permanent.

Port expansion: No port expansion activities are contemplated for the Proposed Action. As such, the Proposed Action would not be expected to contribute appreciably to combined impacts on marine mammals.

Presence of structures: The various types of impacts on marine mammals that could result from the presence of structures are described in detail in Section 3.4.1.1. Using the assumptions in Table A-4, there could be up to approximately 2,944 acres (12 km^2) of new hard protection. Of this area, only 151 acres (0.6 km^2) would result from the proposed Project, and the remainder would result from other offshore wind projects in the geographic analysis area. Of the estimated 2,066 structures, 102 would result from the proposed Project. The structures and scour/cable protection, and the potential consequential impacts would remain at least until decommissioning of each facility is complete (30 years). Structures associated with the Vineyard Wind 1 Project would be expected to provide some level of reef effect and may result in long-term **minor beneficial** impacts on seal and small odontocete foraging and sheltering, though long-term, **minor** impacts could occur as a result of increased interaction with active or ghost fishing gear. NMFS has determined that the gear associated with sink gill net and lobster pots has the potential to affect marine mammals (NOAA 2018a). Of these two gear types, sink gill net is most likely to occur within the proposed Project area as shown in Table 3.10-6a and b. BOEM has determined that the potential for displacement of fixed gear from the Project area is low due to the gear able to be deployed in a fixed location. There is the potential that in the short-term sink gill net effort could shift into the Project area if catch is higher around wind turbine foundations. However, this would be a temporary effect as fishing effort would eventually depress any short-term increases in fish biomass (Roach et al. 2018), assuming that effective fishing without gear entanglement can occur. This impact is anticipated to be short term (1 to 2 years) and would have **negligible**, if any, impacts on marine mammals.

While the significance level of impacts would remain the same, BOEM could further reduce impacts to help alleviate potential mortality and injury with the following mitigation measures conditioned as part of the COP approval (Appendix D): requirement for annual remotely operated underwater vehicle surveys, reporting, monofilament, and other fishing gear cleanup efforts around WTG foundations.

This would remove any identified fishing gear and reduce the potential for impacts on marine mammals to **negligible** levels. While the abandoned fishing gear would be removed, the potential for entanglement associated with active commercial or recreational fishing gear would still exist.

Currently, there is a large amount of uncertainty around large whale response to offshore wind facilities due to the novelty of this type of development in the Atlantic. Monitoring studies would be able to determine more precisely any changes in whale behavior. Based on the best available information, none is anticipated. However, long-term, intermittent **minor** impacts on foraging, migratory movements, or other important behaviors may occur as a result of the Proposed Action. Additionally, temporary displacement from the WDA during Project construction into areas with higher risk of interactions with fishing and commercial vessels (see increased vessel traffic IPF below) may also adversely contribute to impacts on marine mammals.

In context of reasonably foreseeable environmental trends, the combined impacts arising from the presence of structures on the Atlantic OCS from ongoing and planned actions, including Alternative A, would be expected to range from **negligible** to **moderate** impacts and could include **minor beneficial** impacts for some marine mammal species, including delphinids and pinnipeds due to the large number of structures.

Increased vessel traffic: With respect to ship strike risk, Vineyard Wind estimates that a maximum of approximately 46 vessels could operate simultaneously within the WDA or OECC during the proposed Project's most active construction period. In an extreme case, all 46 of these vessels could need to travel to or from New Bedford or a secondary port in the same day; however, Vineyard Wind estimates that activities during the proposed Project's most active period would typically generate 18 vessel trips per day to or from ports. The maximum number of vessels involved in the proposed Project at any one time is highly dependent on the Project's final schedule, the final design of the Project's components, and the logistics solution used to achieve compliance with the Jones Act (COP Section 7.8, Volume III, and Appendix III-I; Epsilon 2020b). Given that vessel strike is relatively common with cetaceans (Kraus et al. 2005), vessel traffic associated with the proposed Project has the potential to pose a high-frequency, high-exposure collision risk to marine mammals especially NARWs, other baleen whales, and calves that spend considerably more time at/near the ocean surface. However, the Proposed Action would be expected to result in only a small incremental increase in vessel traffic, with a peak during Project construction. Based upon the analysis provided in the BO (NMFS 2020b), there are a total of 54,305 annual vessel trips through the WDA and OECC. Using this baseline vessel traffic in the area, the proposed Project would result in 4.7, 1.6, and 4.0 percent annual increases in vessel traffic during construction, operations, and decommissioning, respectively (NMFS 2020b). The NRA (COP Volume III, Appendix III-I; Epsilon 2020b) found that no significant disruption of normal traffic patterns is anticipated in the WDA associated with the proposed Project. Therefore, even if vessel traffic in the region increases, the Proposed Action is not expected to significantly increase the overall risk of vessel allisions or collisions.

Vineyard Wind anticipates that WTG and ESP components, as well as offshore export cables, would be shipped from overseas ports, either directly to the WDA or through a U.S. port. A total of approximately 122 vessel round trips, with approximately 5 round trips per month are anticipated over the 2-year construction schedule. These estimates are based upon the installation of 100 WTGs and represent the maximum-case scenario. It is expected that these vessels would follow the major navigation routes and would be making similar trips to U.S. ports in the absence of the proposed Project (Michael Clayton, Pers. Comm., July 23, 2020).

Temporary and/or permanent increases in vessel traffic outside of the WDAs may also occur due to displacement of commercial and recreational fishing vessels. Bottom tending mobile gear is more likely to be displaced from the WDAs than fixed gear. The expanded planned action scenario would be more likely to displace larger fishing vessels with small mesh bottom-trawl gear and mid-water trawl gear, compared to smaller fishing vessels with similar gear types that may be easier to maneuver. More information regarding the potential for displacement of fishing vessels is provided in Section 3.10.

While the significance level of impacts would remain the same, BOEM could further reduce impacts with the following mitigation measures conditioned as part of the COP approval (Appendix D) by BOEM, which also includes the mitigation, monitoring, and reporting requirements proposed by Vineyard Wind; the mandatory reasonable and prudent measures included in the ITS issued with NMFS September 11, 2020, BO under the ESA (NMFS 2020b); and the conditions required in the final IHA to be issued by NMFS under the MMPA. These include requirement for vessel strike avoidance procedures and protected species reporting to ensure vigilance by vessel crews during transit; requirement for vessel observers to monitor a vessel strike avoidance zone around project vessels; and use of AIS to monitor the number of Project vessels, traffic patterns, and Project vessel compliance with required speed restrictions.

Given the implementation of Project-specific measures, BOEM anticipates that vessel strikes as a result of Alternative A alone are highly unlikely and that impacts on marine mammal individuals through this IPF would be expected to be **minor;** as such, no population-level impacts would be expected.

Vessel strike is one of the primary causes of death to NARWs, with as many as 75 percent of known anthropogenic mortalities of NARWs likely resulting from collisions with large ships along the U.S. and Canadian eastern seaboard (Kite-Powell et al. 2007). The Proposed Action includes a series of measures that Vineyard Wind has committed to voluntarily implement to reduce the potential for vessel strikes of listed species, including the NARW.

- NARW sightings information would be checked daily.
- If a NARW or large whale were observed within 500 yards (457 meters), the transiting vessel would shift the engine to neutral and would not re-engage engines until the NARW has moved out of the vessel path and beyond 500 yards (457 meters) of the vessel.
- A 1,640-foot (500-meter) for NARWs (Vineyard Wind 2018a) and 1,640-foot (500-meter) setback for other listed whale species would be maintained between all transiting construction-related vessels and whales.
- Transiting vessels would maintain a separation distance of 164 feet (50 meters) from all other marine mammals and dolphins.
- If cow/calf pairs or large groups of delphinids were observed within 164 feet (50 meters) of a vessel in transit, the vessel would reduce speed to 10 knots. Normal transit speed would be resumed only after the delphinids have moved outside the 164-foot (50-meter) zone.
- AIS would be required on each Project vessel.

A detailed analysis considering vessel strike from Project vessels for ESA-listed marine mammals is provided in the BO (NMFS 2020b). Given the implementation of the above measures, vessel strikes of ESA listed whales, including NARW, are not anticipated. Given Vineyard Wind's commitment to voluntarily implement the above measures, no impacts on listed marine mammal species would be expected to occur as a result of vessel strike. No take as a result of vessel strike would be authorized by the final IHA or is authorized for large whales in the BO given the implementation of these measures.

In context of reasonably foreseeable environmental trends, the combined vessel traffic impacts on marine mammals from ongoing and planned actions, including Alternative A, could result in **minor** to **moderate** impacts on marine mammals; however**,** BOEM does not expect the viability of marine mammal stocks or populations to be effected. The relative risk of vessel strikes from vessels associated with Alternative A is dependent upon the stage of development (i.e., construction, operations, or decommissioning), time of year, number of vessels, and speed of vessels during each stage.

Climate change: The surveying, construction, and decommissioning activities associated with the proposed Project would produce GHG emissions that can be assumed to contribute to climate change; however, these contributions would be small (i.e., 6,990 metric tons) compared with the aggregate global emissions, and would be less than the emissions offset during the operation of the offshore wind facility. The impact of GHG emissions on marine mammals from the Project would not be detectable. Given that the Proposed Action would produce less GHG emissions than similarly sized fossil-fuel powered generating stations, the combined effects associated with the expected reduction in GHG emissions would be expected to result in long-term, low-intensity, beneficial overall impacts on marine mammals.

Other considerations: For temporary impacts over short time periods, including the effects of pile-driving noise and new cable emplacement, it is likely that a portion—possibly the majority—of such impacts from future activities would not overlap in time with the temporary impacts of the Proposed Action. However, some IPFs such as vessel operations can result in temporary but recurring impacts on marine mammals over the lifetime of projects.

In summary, construction, installation, operation, and decommissioning of Alternative A alone would have **negligible** to **moderate** adverse impacts and could potentially include **minor beneficial** impacts. Adverse impacts are expected to result mainly from pile-driving noise and increased vessel traffic. Beneficial impacts are expected to result from the presence of structures.

In context of reasonably foreseeable environmental trends in the geographic analysis area, impacts from ongoing and planned actions, including Alternative A, are expected to be several times greater than the incremental impacts of the Alternative A alone. However, the incremental impacts of the Alternative A alone would not add to the impacts of the No Action Alternative because, under the planned action scenario described in Section 1.2.1, the total capacity of offshore wind development in the geographic analysis area for marine mammals would be the same whether the Proposed Action goes forward or not. BOEM assumes for this planned action analysis that the number of WTGs would be similar in either case, as would the length of offshore export cable, inter-array cable, and associated disturbances. Thus, the primary differences between the Proposed Action and the No Action Alternative are the locations and times (years) in which the impacts would occur.

In context of other reasonably foreseeable environmental trends and planned actions, in the geographic analysis area, impacts resulting from individual IPFs resulting from ongoing and planned actions, including Alternative A, would range from **negligible** to **moderate**, and may potentially include **minor beneficial** impacts. Considering all the IPFs together, BOEM anticipates that the impacts from ongoing and planned actions, including Alternative A, would result in overall **moderate** impacts on marine mammals in the geographic analysis area. The main drivers for this impact rating are pile driving, vessel, and construction noise, increased vessel traffic associated with the expanded planned action scenario, and ongoing climate change. The Proposed Action would contribute to the overall impact rating primarily through noise-related IPFs and increased vessel traffic. Thus, the overall impact on marine mammals from the Proposed Action in combination with other reasonably foreseeable environmental trends and planned actions would likely be **moderate** because a notable and measurable impact is anticipated, but the resource would likely recover completely when IPF stressors are removed and/or remedial or mitigating actions are taken.

While the significance level of impacts would remain the same, BOEM could further reduce impacts with the following mitigation measures conditioned as part of the COP approval (Appendix D) by BOEM that also includes the mitigation, monitoring, and reporting requirements proposed by Vineyard Wind; the mandatory reasonable and prudent measures included in the ITS issued with NMFS' September 11, 2020, BO under the ESA (NMFS 2020b); and the conditions required in the final IHA to be issued by NMFS under the MMPA. The mandatory measures included in the BO have been designed to reduce the amount and extent of ESA-listed marine mammal take related to pile-driving noise and vessel operations. The following is an integrated summary of the all the conditions required that may minimize or reduce impacts to marine mammals.

- Provide Project personnel with informational training on proper storage and disposal practices to reduce the likelihood of accidental discharges.
- Use long-term PAM buoys or autonomous PAM devices.
- Implement pile-driving noise reduction technologies to achieve a reduction of noise impacts.
- Implement a Pile Driving Monitoring Plan.
- Monitor pile-driving noise to ensure compliance with required noise reductions.
- Enlarge exclusion zones based on field measurements, if necessary to avoid exposure of marine mammals to injurious levels of pile-driving noise.
- Conduct daily preconstruction surveys to ensure that marine mammals and sea turtles are not present in the area during pile driving.
- Use a real-time PAM system to monitor for NARW presence.
- Use PSOs to establish and maintain marine mammal clearance zones prior to and during pile-driving activities.
- Implement pile driving time-of-year restrictions to avoid potential presence of NARW.
- Implement pile driving time-of-day restrictions to ensure that all clearance zones are maintained.
- Conduct NARW-specific geophysical survey monitoring.
- Implement shut-down and power-down procedures.

- Implement enhanced time-of-year shut-down and restart procedures.
- Conduct Daily and weekly reporting of marine mammals observed, if any, during pile driving operations.
- Use PSOs on project vessels.
- Establish a requirement for annual remotely operated underwater vehicle surveys, reporting, monofilament, and other fishing gear cleanup around WTG foundations.
- Establish a requirement for vessel strike avoidance procedures and protected species reporting to ensure vigilance by vessel crews during transit.
- Establish a requirement for vessel overserves to monitor a vessel strike avoidance zone around project vessels.
- Use AIS to monitor the number of Project vessels, traffic patterns, and Project vessel compliance with required speed restrictions.
- NARW sightings information would be checked daily.
- If a NARW or large whale were observed within 500 yards (457 meters), the transiting vessel would shift the engine to neutral and would not re-engage engines until the NARW has moved out of the vessel path and beyond 500 yards (457 meters) of the vessel.
- A 1,640-foot (500-meter) for NARWs (Vineyard Wind 2018a) and 1,640-foot (500-meter) setback for other listed whale species would be maintained between all transiting construction-related vessels and whales.
- Transiting vessels would maintain a separation distance of 164 feet (50 meters) from all other marine mammals and dolphins.
- If cow/calf pairs or large groups of delphinids were observed within 164 feet (50 meters) of a vessel in transit, the vessel would reduce speed to 10 knots. Normal transit speed would be resumed only after the delphinids have moved outside the 164 feet (50-meter) zone.
- AIS would be required on each Project vessel.

3.4.3. Consequences of Alternative C, D1, D2, and E

Alternative C would relocate six of the northernmost WTG locations to the southern portion of the WDA primarily for the purpose of reducing visual impacts and minimizing conflicts with commercial fishing boats. BOEM does not expect that Alternative C would not appreciably change the expected potential impacts on marine mammals because the number of turbines remains the same, and the southern portion of the WDA does not include areas with substantially higher densities of marine mammals.

Under Alternative D1, the total acreage of the WDA could increase by 22 percent (16,603 acres [67 km^2]) to achieve wider spacing between WTGs. Alternative D2 would align WTGs in an east–west orientation with a 1-nautical-mile spacing between all turbines to allow greater spacing between WTG rows, which would facilitate the established practice of mobile and fixed-gear fishing vessels. As previously un-surveyed areas within the WDA will be used for WTG foundation placement, HRG surveys would be required as part of pre-construction Project activities under these Alternatives, and some localized temporary acoustic impacts may occur. However, BOEM believes that Level A Harassment from HRG surveys is unlikely given the PTS distances and the brief duration of the acoustic impacts. While Level B harassment may potentially occur as a result of HRG surveys, implementation of mitigation and monitoring measures, as described above and in Appendix D, would be expected to reduce the likely impacts, if any, to negligible levels. Further, individuals are expected to fully recover following the brief exposure to sounds associated with HRG surveys. During operations and maintenance, Alternatives D1 and D2 would increase the total length of inter-array cables compared to the Proposed Action. BOEM anticipates this difference to increase the potential for long-term EMF-related effects. Since the level of potential impacts from EMF on marine mammals is not well studied, BOEM does not know the extent of any additional long-term impacts associated with additional inter-array cabling required under these Alternatives. BOEM anticipates that all other expected potential impacts associated with Alternatives D1 and D2 would not be measurably different from those anticipated under Alternative A and would not change the anticipated impact rating.

Under Alternative E, there would be a 16 percent reduction in the number of WTGs (assuming the installation of no more than 84 WTGs), which would translate into a reduction of pile-driving days, vessel traffic, duration of acoustic impacts, and fewer impacts on water quality and the benthic environment. Additionally, there would be a reduction in WTG and ESP scour protection, inter-array cable, and inter-array cable protection. As such, BOEM anticipates a decrease in potential impacts and as a result, less incidental take of ESA-listed marine mammals (NMFS 2020b) during construction and installation, operations and maintenance, and decommissioning compared with Alternative A. These impacts would not be expected to change the anticipated impact rating. BOEM anticipates the impacts resulting from individual IPFs associated with Alternatives C, D1, D2, and E to have potential **negligible** to **moderate** impacts and potential **minor beneficial** impacts on marine mammals associated with Project construction, operations and maintenance, and decommissioning.

In context of reasonably foreseeable environmental trends, the combined impacts from ongoing and planned actions, including Alternatives C, D1, D2, or E, would be similar to those described under Alternative A (with impacts from individual IPFs ranging from **negligible** to **moderate** and may include **minor beneficial** impacts). While Alternatives D1 and D2 may be slightly more impactful to marine mammals than Alternative A and Alternative E may be slightly less impactful to marine mammals, the impacts under Alternatives C, D1, D2, and E would be similar to those impacts described under Alterative A. The overall impacts on marine mammals in the geographic analysis area of Alternatives C, D1, D2, or E, in combination with reasonably foreseeable trends and planned projects would be of the same level as described under Alternative A—**moderate**. This impact rating is driven mostly by ongoing activities, such as climate change, fishery gear interactions, military readiness activities, and vessel traffic, as well as by the construction, installation, and presence of offshore wind structures.

3.4.4. Consequences of Alternative F

Alternative F, combined with the Alternative A or Alternative D2 layouts, would potentially lead to a slightly increased risk of resident or migrating marine mammals encountering the WDA or Project-related vessels with associated impacts as described above. Some additional loss of potentially suitable habitat for marine mammal species that avoid the WDA entirely could occur under Alternative F. Additionally, concentrating non-Project vessel traffic into a corridor may result in increased potential for vessel strikes and behavioral responses to vessel noise due to funneling of existing vessel traffic through the transit lane. When compared to Alternative A or Alternative D2 alone, the impacts of Alternative F would be slightly increased due to the potential for longer transits to the WDA during construction, operations, and decommissioning, and result in an increase in associated collision risk. However, these impacts resulting from individual IPFs would be expected to still result in **negligible** to **moderate** impacts and potential **minor beneficial** impacts, with no measurable differences to those described under Alternative A. This is due to the total number of WTGs and associated impacts remaining the same, and the southern portion of the WDA not including areas with higher densities of marine mammals. The impacts from the combination of Alternative F with Alternative A or Alternative D2 are expected to be similar to combinations with the other alternatives. In combination with Alternative C, Alternative F would require six additional WTGs to be relocated. In combination with Alternative E, a reduced number of WTGs would be relocated. Overall, however, Alternative F in combination with these two alternatives would not change the level of impacts on marine mammals described above. Consequently, these other potential combinations are not separately analyzed here.

BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. In context of reasonably foreseeable environmental trends, the impacts of ongoing and planned actions, including Alternative F, would not likely be materially different than the combined impacts under the Proposed Action (with individual IPFs leading to impacts ranging from **negligible** to **moderate** and may include **minor beneficial** impacts). The overall impacts of Alternative F in combination with reasonably foreseeable trends and planned projects would not be expected to be materially different from Alternative A—**moderate**. This impact rating is driven mostly by ongoing activities, such as climate change, fishery gear interactions, military readiness activities, and vessel traffic, as well as by the construction, installation, and presence of offshore wind structures.

BOEM has qualitatively evaluated the combined impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. To the extent additional transit lanes are implemented in the future outside the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located farther from shore, similar to the proposed Project under Alternative F. As discussed in Section 3.3.2, if all the proposed transit lanes were implemented, this would not allow the technical capacity of offshore wind power generation assumed in Chapter 1 to be met. If in the future all six transit lanes were implemented, the overall number of WTGs would likely be less and consequently result in less pile driving and lower temporary noise impacts on marine mammals. The combined impacts on marine mammals from six transit lanes may result in slightly greater impacts due to funneling of ongoing non-Project related vessel traffic and associated collision risk, but the impacts would be expected to remain the same as a result of the patchy distribution of marine mammals in the geographic analysis area.

Overall, the impacts of Alternative F alone on marine mammals would likely be **negligible** to **moderate**, including the presence of structures, which may result in **minor beneficial** impacts. The overall impacts on marine mammals from ongoing and planned actions, including Alternative F, would be of the same level as under Alternative A—**moderate**. The width of the transit lane and the other alternative(s) with which Alternative F is combined could slightly modify the amount of impacts by modifying the amount of incremental impact, as discussed above; however, the overall level of impacts would be similar for any contemplated version of Alternative F (**moderate**), which is driven mostly by ongoing activities, such as climate change, anthropogenic noise, and vessel traffic, as well as by the construction, installation, and presence of offshore wind structures.

As described above, Vineyard Wind's existing voluntary and required commitments to mitigation measures, and BOEM's potential additional mitigation measures could further reduce impacts but would not change the impact ratings.

3.4.5. Comparison of Alternatives

As discussed above, the impacts and the potential beneficial impacts associated with the Alternative A alone would not change substantially under Alternatives C through F. While the alternatives have some potential to result in slightly different impacts on marine mammals, the same construction, operations and maintenance, and decommissioning activities would still occur, albeit at differing scales in some cases. Alternatives D1, D2, and F may result in slightly more, but not measurably different, impacts due to an expanded Project footprint and required additional HRG surveys. Alternative E may result in slightly less, but not measurably different, impacts due to a reduced number of WTGs and Project footprint. Furthermore, in context of reasonably foreseeable environmental trends and planned actions, impacts on marine mammals would be slightly higher, but not measurably different, under Alternatives D1, D2, and F, and slightly lower, but not measurably different under Alternative E. However, the overall impact of any action alternative when combined with other planned actions would be similar because the majority of the impacts result from ongoing activities and other future offshore wind projects, which does not materially change between alternatives. See Table 2.4-1 for a comparison of alternative impacts.

3.4.6. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. Under the Preferred Alternative, the WDA would contain between 57 to 84 WTGs. This alternative would include at least 16 percent reduction of the number of WTGs from the Proposed Action, resulting in a reduction of pile-driving days, vessel traffic, duration of acoustic impacts, and impacts on water quality and the benthic environment. Considering the mitigation measures included as part of the Preferred Alternative, overall impacts are expected to range from **negligible** to **moderate** (dependent on species and IPF) and could potentially include **minor beneficial** impacts to small cetaceans and seals due to prey aggregations and increased foraging opportunities around WTG foundations. The Preferred Alternative would further reduce potential impacts on marine mammals by imposing mitigation measures outlined Appendix D including the measures required in the final IHA and the Reasonable and Prudent Measures and implementing Terms and Conditions of the ITS included with NMFS September 11, 2020, BO, which could include daily pre-construction PAM and visual surveys; the sunrise and sunset prohibition on pile driving; and the use of noise reduction technologies during all pile-driving activities to achieve a required minimum attenuation (reduction) of 6 dB re 1 μPa RMS; as well as additional monitoring measures (NMFS 2020b). The specific technologies are yet to be selected, but potential options include a Noise Mitigation System, Hydro-sound Damper, Noise Abatement System, a bubble curtain, or similar (Pyć et al. 2018). In addition to the use of one sound attenuation system, Vineyard Wind has committed to complete sound field verification and to have a second attenuation technology on hand that would be deployed if sound field verification demonstrates a need for greater attenuation. The above measures would reduce noise during construction and the likelihood of noise impacts on marine mammals but would not result in a change to the significance level of impacts compared to Alternative A.

Therefore, BOEM anticipates that the impacts of noise would remain **minor** for NARWs and **moderate** for all other marine mammals. Other potential measures that would reduce effects for the Preferred Alternative, as mentioned in Appendix D, include the non-governmental organization agreement that includes elements to minimize effects on NARWs, including refinement of exclusion zones for construction activities. The Preferred Alternative would also reduce potential impacts on marine mammals when compared to Alternative A by implementing the requirement of AIS on all Project vessels, which would allow the number of vessels and traffic patterns to be monitored for compliance with vessel speed requirements, and would decrease the potential for vessel strike for marine mammals and result in **negligible** impacts. In addition, similar to the Proposed Action, the presence of structures in the Preferred Alternative would lead to **minor beneficial** impacts to some marine mammal species due to due to prey aggregations and increased foraging opportunities around WTG foundations.

3.5. Sea Turtles

3.5.1. No Action Alternative and Affected Environment

This section discusses existing sea turtle resources in the geographic analysis area, as described in Table A-1 in Appendix A and shown on Figure A.7-6, namely, the Scotian Shelf, Northeast Shelf, and Southeast Shelf LMEs, which are likely to capture the majority of the movement range within U.S. waters for most species in this group. Table 3.5-1 contains a detailed summary of baseline conditions and the anticipated impacts, based on IPFs assessed, of ongoing and future offshore activities other than offshore wind, which is discussed below.

Five ESA-listed species of sea turtles may occur in the U.S. northwest Atlantic Ocean: leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), green (*Chelonia mydas*), and hawksbill (*Eretmochelys imbricate*). All of these sea turtles are migratory and enter New England waters primarily in the summer and fall. Hawksbill sea turtles are rare in Massachusetts, and not likely to occur in the area; therefore, this FEIS does not consider them further.

The combination of sightings, strandings, and bycatch data provides the best available information on sea turtle distribution in the proposed WDA. This section summarizes data from the most current sightings surveys of the waters around the Massachusetts Lease Areas (including the WDA; Kraus et al. 2016a), NMFS Sea Turtle Stranding and Salvage Network (NMFS 2018c), most recent available density estimates (Pyć et al. 2018), and historic regional data (Kenney and Vigness-Raposa 2010). Table 3.5-2 summarizes sea turtle occurrence in southern New England coastal waters off Rhode Island and Massachusetts. Prey items vary with species, and detailed foraging information is provided in the BO issued by NMFS (2020).

The Wellfleet Bay Wildlife Sanctuary strandings data (WBWS 2018) are shown on Figure 3.5-1. The Northeast Fisheries Observer Program statistical area 537 encompasses the waters from the southern shores of Martha's Vineyard and Nantucket south (including the proposed Project area) to the OCS waters off New York (NMFS 2018a). NMFS bycatch data in this area indicated that a total of 31 turtles (4 leatherback, 2 green, 20 loggerhead, and 5 unidentified hard-shelled turtles) were incidentally caught in monkfish, squid, and skate fishery gear from 2008 through 2017 (NMFS 2018a). These data under-represent the actual number of bycaught turtles due to the limited observer coverage for each fishery. The turtles were caught from June through December, with the majority in July (18 of 31) and August (5 of 31). In area 538, which includes the waters from the south shore of Cape Cod to the southern shores of Martha's Vineyard and Nantucket (and the proposed Project OECC area), one loggerhead turtle was incidentally caught in August of 2014 (NMFS 2018a).

Kraus et al. (2016b) sighted three species of sea turtles in the waters around the Massachusetts Lease Areas from October 2011 through June 2015: leatherback, loggerhead, and Kemp's ridley. Leatherback (161 sightings) and loggerhead sea turtles (87 sightings) were the most commonly sighted species occurring mostly during summer and fall, with a few sightings of both species in the spring (Kraus et al. 2016a). Kraus et al. (2016b) sighted a total of six Kemp's ridley sea turtles: one in August and five in September. Over their study period, Kraus et al. (2016b) observed 30 unidentifiable sea turtles. Because of their high submergence rate, sea turtles are difficult to spot during surveys, and their numbers in waters around the Massachusetts Lease Areas are likely to be an underestimate. There were no sightings of any species of sea turtle during the winter season. Although Kraus et al. (2016b) did not observe green sea turtles during the surveys, stranding records indicate the presence of green sea turtles in the area.

See Appendix E for the sightings per unit effort (SPUE) for loggerhead, leatherback, Kemp's ridley, and unidentified sea turtles in the Project area (Appendix E Figures E.5-5 through E.5-8). Additional information on sea turtle occurrence in the proposed Project area is available in the BO (NMFS 2020b).

Density estimates based on the most recent sightings data are not available for all sea turtles in the WDA. Although density estimates for the Project area are limited, Pyć et al. (2018) summarized seasonal estimates of sea turtle densities using data from the U.S. Navy Operating Area Density Estimate database (Table 3.5-3). Sea turtle density estimates herein are derived from Strategic Environmental Research and Development (SERDP) Spatial Decision Support System (SDSS) and represent the best data set to be used for animal movement modeling, as agreed to by BOEM and NMFS on July 24, 2018. Additional reports do not contain density estimates but rather SPUEs and were considered as supplemental information in the DEIS, SEIS, and the BO. A detailed discussion of density estimates can be found in the BO (NMFS 2020b). These estimates suggest that loggerhead sea turtles are the most likely species of sea turtle found in the proposed Project area, and their densities would be highest during summer (Table 3.5-3; Pyć et al., 2018). Additionally, leatherback sea turtles may also occur in the Project area during spring, fall, and winter (Table 3.5-3). Details on data handling to develop these estimates are available in Pyć et al. (2018).

While in the coastal waters in and near the proposed Project area, sea turtles may be found swimming, foraging, migrating, diving at depth for extended periods, basking at the surface (Spotila and Standora 1985), and possibly engaged in extended rest periods on the ocean bottom. All sea turtle species are susceptible to the effects of vessel traffic, with potential impacts including behavioral modification from vessel noise and vessel strike. Other potential acoustic impacts could include behavioral modification during proposed Project construction, including potential injury during pile-driving activities. Benthic forage prey for loggerheads, green, and Kemp's ridley sea turtles (including crustaceans, mollusks, and vegetation) could be impacted by proposed Project activities that would affect the seafloor. Sea turtles are known to orient to changes in EMFs emitted from power cables, which are likely detectable by sea turtles at close ranges (Normandeau et al. 2011), but no adverse effects on sea turtles from the numerous submarine power cables around the world have been documented to occur. A detailed effects analysis for sea turtles was completed and is available in the BO (NMFS 2020b). There are no nesting beaches or other nearshore critical habitats for sea turtles in the proposed Project area; therefore, potential impacts associated with onshore Project components are not evaluated in this section.

Sea turtles are wide-ranging and long-lived, making population estimates difficult, and methods vary depending on species (TEWG 2007; NMFS and USFWS 2013, 2015). Since sea turtles have large ranges and highly migratory behaviors, the current condition and trend of sea turtles are affected by factors outside the proposed Project area. For details on nesting habits for the four sea turtle species, see BOEM's (2014a) revised Environmental Assessment and the BO (NMFS 2020b).

- Leatherback:
  - The population estimate (total number of adults) in the Atlantic is 34,000 to 94,000 (NMFS and USFWS 2013; TEWG 2007).
  - Aside from the western Caribbean, nesting trends at all other Atlantic nesting sites are generally stable or increasing (NMFS and USFWS 2013; TEWG 2007).
- Loggerhead:
  - Regional abundance estimate in the Northwest Atlantic Continental Shelf in 2010 was approximately 588,000 adults and juveniles of sufficient size to be identified during aerial surveys (interquartile range of 382,000 to 817,000; NEFSC and SEFSC 2011).
  - While some progress has been made since publication of the 2008 Loggerhead Sea Turtle Recovery Plan, the recovery units have not met most of the critical benchmark recovery criterion (NMFS and USFWS 2019).
- Kemp's ridley:
  - The population was severely decimated in 1985, due to intensive egg collection and fishery bycatch, with only 702 nests counted during the entire year (NMFS and USFWS 2015; Bevan et al. 2016). Recent models indicate a persistent reduction in survival and/or recruitment to the nesting population suggesting that the population is not recovering (NMFS and USFWS 2015).

  - Evaluations of hypothesized causes of the nesting setback, including the Deepwater Horizon oil spill in 2010, have been inconclusive, and experts suggest that various natural and anthropogenic causes could have contributed to the nesting setback either separately or synergistically (Caillouet et al. 2018).
- North Atlantic DPS of green sea turtles:
  - The primary nesting beaches are Costa Rica, Mexico, United States (Florida), and Cuba. According to NMFS and USFWS (2014), nesting trends are generally increasing for this DPS.

All sea turtle species in the geographic analysis area are subject to regional, pre-existing threats including, but not limited to, entanglement in fisheries gear, fisheries bycatch, vessel strike, nesting beach impacts, and climate change. In addition, loggerhead, Kemp's ridley, and green sea turtles are susceptible to cold stunning or the hypothermic reaction that occurs when sea turtles are exposed to prolonged cold-water temperatures, causing a decreased heart rate, decreased circulation, and lethargy, followed by shock, pneumonia, and possibly death. Commercial fisheries occurring in the southeastern New England region include bottom trawl, midwater trawl, dredge, gillnet, longline, and pots and traps (COP Section 7.8, Volume III; Epsilon 2020b), all of which can lead to impacts on sea turtles due to entanglement and bycatch. Commercial vessel traffic in the region is variable depending on location and vessel type. The commercial vessel types and relative density in the Project region during 2013 includes cargo (low), passenger (high), tug-tow (high), and tanker (low; COP Volume III, Section 7.8; Epsilon 2020b). This vessel traffic can lead to injury and/or mortality of individuals due to vessel strikes. These ongoing impacts on sea turtles, especially fisheries interactions and commercial vessel traffic, would continue regardless of the offshore wind industry.

3.5.1.1. Future Offshore Wind Activities (without Proposed Action)

BOEM expects future offshore wind activities to affect sea turtles through the following primary IPFs.

Accidental releases: Accidental releases of fuel/fluids/hazmat, and/or trash and debris may increase as a result of future offshore wind activities. See Section A.8.2 in Appendix A for a discussion of the nature of releases anticipated. 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.

In the expanded planned action scenario, Table A-4 in Appendix A, there would be a low risk of a leak of fuel/fluids/hazmat from any single one of approximately 2,021 WTGs, each with approximately 5,000 gallons (18,927 liters) stored. Total fuel/fluids/hazmat within the geographic analysis area would be approximately 13.1 million gallons (49.6 million liters). According to BOEM's modeling (Bejarano et al. 2013), a release of 128,000 gallons (484,533 liters) 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 ESPs 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. Sea turtle exposure to aquatic contaminants and inhalation of fumes from oil spills can result in mortality (Shigenaka 2010) or sublethal effects on individual fitness, including adrenal effects, dehydration, hematological effects, increased disease incidence, liver effects, poor body condition, skin effects, skeletomuscular effects, and several other health effects attributed to oil exposure (Bembenek-Bailey et al. 2019; Camacho et al. 2013; Mitchelmore et al. 2017; Shigenaka et al. 2010; Vargo et al. 1986). Additionally, accidental releases may result in impacts on sea turtles due to effects on prey species (Table 3.3-1). Based on the volumes potentially involved, the likely amount of additional releases associated with future 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. BOEM assumes all vessels will comply with laws and regulations to minimize releases. In the unlikely event of a trash or debris release, it would be an accidental, localized event in the vicinity of Project areas. Ingestion of plastic fragments is well documented and has been observed in all species of sea turtles (Bugoni et al. 2001; Hoarau et al. 2014; Nelms et al. 2016; Schuylar et al. 2014). In addition to plastic debris, ingestion of tar, paper, Styrofoam, wood, reed, feathers, hooks, lines, and net fragments have also been documented (Thomás et al. 2002). Ingestion can also occur when individuals mistake debris for potential prey items (Gregory 2009; Hoarau et al. 2014; Thomás et al. 2002). Ingestion of marine debris varies among species and life stages due to differing feeding strategies (Nelms et al. 2016). Ingestion of plastics and other marine debris can result in both lethal and sublethal impacts on sea turtles, with sublethal effects more difficult to detect (Gall and Thompson 2015; Hoarau et al. 2014; Nelms et al. 2016; Schuyler et al. 2014). Long-term sublethal effects may include dietary dilution, chemical contamination, depressed immune system function, poor body condition as well as reduced growth rates, fecundity, and reproductive success. However, some of these effects are not well understood and clear causal links are difficult to identify (Nelms et al. 2016). While precautions to prevent accidental releases would be employed by vessels and port operations associated with future 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. In the event of a release, it would be an accidental, low-probability event in the vicinity of Project areas or the areas from ports to the Project areas used by vessels.

EMF: Sea turtles are known to possess geomagnetic sensitivity (but not electro sensitivity) used for orientation, navigation, and migration (Lohmann et al. 1997). Sea turtles appear to have a detection threshold of magnetosensitivity and behavioral responses to field intensities ranging from 0.0047 to 4,000 µT for loggerhead turtles, and 29.3 to 200 µT for green turtles, with other species likely similar due to anatomical, behavioral, and life history similarities (Normandeau et al. 2011). In the expanded planned action scenario, up to 5,947 miles (9,571 kilometers) of cable would be added in the geographic analysis area for sea turtles, producing EMF in the immediate vicinity of each cable during operations. Submarine power cables in the geographic analysis area for sea turtles are assumed to be installed with appropriate shielding and burial depth to reduce potential EMF from cable operation to low levels. Juvenile and adult sea turtles may detect the EMF over relatively small areas near cables (e.g., when resting on the bottom or foraging on benthic organisms near cables or concrete mattresses). There are no data on impacts on sea turtles from EMFs generated by underwater cables, although anthropogenic magnetic fields can influence migratory deviations (Luschi et al. 2007; Snoek et al. 2016). Lohmann et al. (2008) speculated that navigation methods used by adult and juvenile sea turtles were dependent upon the stage of migration, initially relying on magnetic orientation**.** While the specific mechanisms of leatherback sea turtle navigation is not currently known, it is believed that they possess a compass sense similar to hardshell turtle species, possibly related to geomagnetic cues (Eckert et al. 2012; Luschi et al. 2007; NMFS and USFWS 2013). As such, while EMF associated with offshore wind development submarine cables would likely result in some deviations from a direct route, these deviations would likely be minor (Normandeau et al. 2011), and no biologically significant impacts due to increased energy expenditure would be expected. Further discussion of potential EMF effects on sea turtles is available in the Vineyard Wind BA and associated BO (BOEM 2019d; NMFS 2020b).

Light: Offshore wind development would result in additional light from vessels and from offshore structures at night. Anthropogenic light sources on the OCS associated with offshore structures or Project vessels may result in short-term, low-intensity impacts, including attraction, avoidance, or other behavioral responses that are expected to be localized and temporary. Potential impacts on sea turtles due to anthropogenic light would be increased primarily during construction, but also during operations and decommissioning of offshore wind facilities.

Ocean vessels have an array of lights including navigational, deck, and interior lights. Such lights have some limited potential to attract sea turtles, although the impacts, if any, are expected to be localized and temporary, and would be expected to dissipate once the vessel or the turtle has left the area.

Under the expanded planned action scenario, up to 2,021 WTGs and 45 ESPs would be constructed incrementally over time, beginning in 2022 and continuing through 2030, on the OCS where few lighted structures currently exist. These would have minimal yellow flashing navigational lighting and red flashing FAA hazard lights in accordance with BOEM's (2019a) lighting and marking guidelines. BOEM assumes that offshore wind projects will be sited offshore, away from nesting beaches and would not disorient nesting females or hatchling sea turtles. As such, no impacts on these life history stages would be expected. At this time, there is some uncertainty regarding the potential for lighting associated with offshore WTG and ESP platforms to generate sufficient downward illumination to affect sea turtles, depending on species or life history stage. However, per BOEM (2019a) guidance, direct lighting would be avoided and indirect lighting of the water surface would be minimized to the greatest extent practicable. In laboratory experiments, captive-reared juvenile loggerhead turtles consistently oriented toward glowing lightsticks of all colors and types used by pelagic longline fisheries (Wang et al. 2019). These results indicate that WTG and ESP lighting may attract loggerhead, and possibly Kemp's ridley and green sea turtles. In a separate study, Gless et al. (2008) determined that juvenile leatherback sea turtles do not appear to be attracted to light. Gless et al. (2008)

indicated that most juvenile leatherbacks, in contrast to loggerheads, either failed to orient or oriented at an angle away from the lights. The authors suggested that older, adult turtles might show responses that differ from those of juvenile turtles. Gless et al. (2008) also reviewed previous studies based on fisheries logbook data and concluded that because of confounding factors, there is no convincing evidence that marine turtles are attracted to lights used in longline fisheries. Orr et al. (2013) indicated that lights on wind generators that flash intermittently for navigation or safety purposes do not present a continuous light source, and thus do not appear to have disorientation effects on juvenile or adult sea turtles. Although the potential effects of offshore lighting on juvenile and adult sea turtles is uncertain, WTG lighting is not anticipated to have any detectable effects (adverse or beneficial) on any age class of sea turtles in the offshore environment given the current lack of evidence that platform lighting leads to effects on sea turtles as shown by decades of oil and gas platform operation in the Gulf of Mexico, which can have considerably more lighting than offshore WTGs (BOEM 2019d).

New cable emplacement/maintenance: The impact on water quality from sediment suspension during cable-laying activities is expected to be temporary and short-term. Using the assumptions in Table A-4 in Appendix A, the total area of seafloor disturbed by cable emplacement for offshore wind facilities is estimated to be up to 8,153 acres (33.0 km^2) beginning in 2022 and continuing through 2030. In addition to cables related to individual offshore wind facilities, two unsolicited proposals for the development of two open access offshore transmission systems have been announced. The routes for these proposed regional cables have not been determined at this time and are not considered reasonably foreseeable, but BOEM assumes that if future offshore wind projects use one of these open access transmission systems, the impacts associated with new cable emplacement and maintenance activities would be less than if each individual project installed its own cable. Data are not available regarding effects of suspended sediments on adult and juvenile sea turtles, although elevated suspended sediments may cause individuals to alter normal movements and behaviors. However, these changes are expected to be too small to be detected (NOAA 2020i). Sea turtles would be expected to swim away from the sediment plume. Elevated turbidity is most likely to temporarily affect the foraging behavior of sea turtles by attracting prey to feed on detritus or by interference with visual prey detection, but no impacts due to swimming through the plume would be expected (NOAA 2020i). Turbidity associated with increased sedimentation may result in temporary, short-term impacts on some sea turtle prey species, including benthic mollusks, crustaceans, sponges, sea pens, and crabs (Table 3.3-1). While the cable routes for future offshore wind developments are unknown at this time, the areas subject to increased suspended sediments from simultaneous activities would be limited and all impacts would be localized and temporary. Sediment plumes would be present during construction for 1 to 6 hours at a time. Any dredging necessary prior to cable installation could also contribute additional impacts. Additional impacts related to impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques could also occur. Mechanical dredging is not expected to result in the capture, injury, or mortality of sea turtles (USACE 2020). Sea turtles are vulnerable to impingement or entrainment in hopper dredges, which can result in injury or mortality. However, the risk of interactions between hopper dredges and individual sea turtles is expected to be lower in the open ocean areas where dredging may occur compared to nearshore navigational channels (Michel et al. 2013; USACE 2020). This may be due to the lower density of sea turtles in these areas as well as differences in behavior and other risk factors. Given the available information, the risk of injury or mortality of individual sea turtles resulting from dredging necessary to support projects considered here is low and population-level effects are unlikely to occur.

Noise: Anthropogenic noise on the OCS associated with future offshore wind development has the potential to result in impacts on sea turtles, including potential auditory injuries, altered submergence patterns, short-term disturbance, startle response (diving or swimming away), and short-term displacement of feeding/migrating and a temporary stress response, if present within the ensonified area (NSF and USGS 2011; Samuel et al. 2005). Potential impacts may occur due to noise from Project aircraft, G&G surveys, operational WTGs, pile driving, cable laying, and vessel traffic.

Future offshore wind development may require the use of helicopters to supplement crew transport during construction and operations. BOEM expects that helicopters transiting to the offshore WDAs would fly at altitudes above those that would cause behavioral responses from sea turtles except when flying low to inspect WTGs or take-off and landing on the SOV. Currently, no published studies describe the impacts of aircraft overflights on sea turtles, although anecdotal reports indicate that sea turtles respond to aircraft by diving (BOEM 2017). While helicopter traffic may cause some short-term and temporary non-biologically significant behavioral reactions, including startle responses (diving or swimming away), altered submergence patterns, and a temporary stress response (BOEM 2017; NSF and USGS 2011; Samuel et al. 2005), these brief responses would be expected to dissipate once the aircraft has left the area.

Without mitigation, G&G surveys for future offshore wind facilities have the potential to result in long-term impacts on sea turtles, including potential auditory injuries, stress, disturbance, and behavioral responses, if present within the ensonified area. The potential for PTS and TTS is considered possible in proximity to active acoustic surveys, but impacts are unlikely as turtles would be expected to avoid such exposure and survey vessels would pass quickly (NSF and USGS 2011). It is important to note that G&G noise resulting from offshore wind site characterization surveys is quieter and affects a much smaller area 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 more similar to common deep-water echosounders. Site characterization surveys for offshore wind facilities would create intermittent noise around sites of investigation over a 2- to 10-year period. Seismic surveys can extend over a time scale of months, as does construction and installation of wind energy structures. However, identifying the locations and schedules of wind energy G&G and construction/installation activities as well as ongoing and future non-offshore wind G&G surveys could avoid overlapping noise impacts by scheduling activities to avoid collective impacts on sea turtles. BOEM has concluded that sea turtle disturbance from underwater noise generated by site characterization and site assessment activities would likely result in temporary displacement and other behavioral or non-biologically significant physiological consequences (BOEM 2019d), and impacts on sea turtles would not result in stock or population-level effects.

Noise associated with operational WTGs, while audible to sea turtles, would not be expected to result in measurable impacts on individuals as the SPLs generated by WTGs would be expected to be at or below ambient levels at a relatively short distance from WTG foundations (Kraus et al. 2016a; Thomsen et al. 2015). According to measurements at the Block Island Wind Farm, low frequency noise generated by turbines reaches ambient levels at 164 feet (50 meters; Miller and Potty 2017). SPL measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa at 46 and 65.6 feet (14 and 20 meters) from the WTGs (Tougaard et al. 2009). Although SPLs may be different in the local conditions of a project area, if sound levels at the Project area are similar, operational noise could be slightly higher than ambient, which ranged from 96 to greater than 103 dB re 1 µPa in the 70.8 to 224 Hz frequency band at the Block Island Wind Facility study area during 50 percent of the recording time between November 2011 and March 2015 (Kraus et al. 2016a). As such, no impacts on individual sea turtles would be expected to occur.

Noise from pile driving would occur during foundation installations for offshore structures for 4 to 6 hours at a time over a 6- to 10-year period. Under the expanded planned action scenario, up to 2,021 WTGs and 45 ESPs would be constructed incrementally over time, beginning in 2022 and continuing through 2030. Sea turtles would be displaced up to 6 hours per day during monopile installation and up to 14 hours per day during jacket installation. Thus, foraging disruptions, if any, would be temporary and are not expected to last longer than a day. This displacement would result in a relatively small energetic consequence that would not be expected to have long-term impacts on sea turtles. Although information is lacking, construction activities could temporarily displace animals into areas that have a lower foraging quality, or result in higher risk of interactions with ships or fishing gear. Potential impacts on sea turtles from multiple construction activities within the same calendar year could affect migration, feeding, breeding, and individual fitness. Intermittent, long-term impacts may be high intensity and a high exposure level. The magnitude of these impacts would be dependent upon the locations of concurrent construction as well as the number of hours per day, the number of days that pile driving would occur, and the time of year when pile driving is performed. Individuals repeatedly exposed to pile driving over a season, year, or life stage may incur energetic costs with the potential to lead to long-term consequences (Navy 2018). However, individuals may become habituated to repeated exposures over time and ignore a stimulus that was not accompanied by an overt threat (Hazel et al. 2007); individuals have been shown to retain this habituation even when the repeated exposures were separated by several days (Bartol and Bartol 2011; Navy 2018).

Noise associated with cable laying would be produced during initial route identification surveys, trenching, jet plow embedment, backfilling, and cable protection installation by vessels and equipment, with intensity and propagation dependent upon bathymetry, local seafloor characteristics, vessels and equipment used (Taormina et al. 2018). Modeling using *in situ* data collected during cable laying operations in Europe estimates that underwater noise would remain above 120 dB re 1 μPa in an area of 98,842 acres (400 km^2) around the source (Bald et al. 2015; Nedwell and Howell 2004; Taormina et al. 2018). Data regarding threshold levels for impacts on sea turtles from sound exposure during construction are very limited and no regulatory threshold criteria have been established for sea turtles (see noise from pile driving above for more information). If cable-laying activities were to occur 24 hours per day, the DP vessel would be continually moving along the cable route over a 24-hour period. The area within the 120 dB RMS isopleth would also be constantly moving over the same period. Thus, the estimated ensonified areas would not remain in the same location for more than a few hours, and it is unlikely that the sound exposure related to cable-laying activities would result in adverse effects on sea turtles.

The frequency range for vessel noise (10 to 1,000 Hz; MMS 2007a) overlaps with sea turtles' most sensitive hearing range (less than 1,000 Hz with maximum sensitivity between 200 to 700 Hz; Bartol 1994) and would therefore be audible. However, Hazel et al. (2007) suggest that sea turtles' ability to detect approaching vessels is primarily vision-dependent, not acoustic. Sea turtles may respond to vessel approach and/or noise with a startle response (diving or swimming away) and a temporary stress response (NSF and USGS 2011). Samuel et al. (2005) indicated that vessel noise can have an effect on sea turtle behavior, especially their submergence patterns. BOEM anticipates that the potential effects of noise from construction and installation vessels would elicit brief responses to the passing vessel that would dissipate once the vessel or the turtle left the area. Based on the vessel traffic generated by the proposed Project, it is assumed that construction of each individual offshore wind project (estimated to last 2 years per project) would generate an average of 25 and a maximum of 46 vessels operating in the geographic analysis area for sea turtles at any given time, although actual vessel trips would vary by project based on individual project design and port locations. This increase in vessel traffic and associated noise impacts would be at its peak in 2024, when at least four offshore wind projects (not including the Proposed Action) would be under simultaneous construction along the East Coast, i.e., a total of approximately 125 to 230 vessels in the analysis area at any given time during peak construction.[10] Additional information regarding the expected increase in vessel traffic is provided in Section 3.11. This increased offshore wind-related vessel traffic during construction, and associated noise impacts, could result in repeated localized, intermittent, short-term impacts on sea turtles and result in brief behavioral responses that would be expected to dissipate once the vessel or the turtle has left the area. However, BOEM expects that these brief responses of individuals to passing vessels would be unlikely given the patchy distribution of sea turtles, and no stock or population-level effects would be expected.

Port utilization: Increases in global shipping traffic and expected increases in port activity along the East Coast from Maine to Virginia will require port modifications to receive the increase in shipping traffic and increased ship size. However, future offshore wind development is expected to be a minor component of port expansion activities required to meet increased commercial, industrial, and recreational demand. The current bearing capacity of existing ports is considered suitable for wind turbines, requiring no port modifications for supporting offshore wind energy development (DOE 2014). Future channel deepening that may be necessary to accommodate larger ships required to carry offshore WTG components and/or increased vessel traffic associated with offshore wind projects may result in increased potential high-intensity impacts including entrainment and vessel strikes, but exposure would be expected to be moderate and risk highly localized to nearshore habitats. At least two proposed offshore wind projects are contemplating port expansion/modification in Vineyard Haven and in Montauk. Other ports would likely be upgraded along the East Coast, and some of this may be attributable to supporting the offshore wind industry. These port expansions would increase the total amount of disturbed benthic habitat, potentially resulting in impacts on some sea turtle prey species. However, the expected disturbance of benthic habitat, and resulting impacts on sea turtles, would likely be a small percentage of available benthic habitat overall. Increases in port utilization due to other offshore wind projects will lead to increases in vessel traffic. This increase would be at its peak during construction activities and would decrease during operations, but would increase again during decommissioning. In addition, any port expansion and construction activities related to the additional offshore wind projects would add to increased turbidity in the coastal waters.

[10] As specified in Section 1.7, BOEM's analysis of the expanded planned action scenario assumes that the potential vessel availability and supply chain challenges will be overcome and projects will advance as specified in the scenario.

Presence of structures: The presence of structures can lead to impacts, both beneficial and adverse, on sea turtles through localized changes to hydrodynamic disturbance, prey aggregation and associated increase in foraging opportunities, incidental hooking from recreational fishing around foundations, entanglement in lost and discarded fishing gear, migration disturbances, and displacement. These impacts may arise from buoys, met towers, foundations, scour/cable protections, and transmission cable infrastructure during any stage of a project. Using the assumptions in Table A-4 in Appendix A, the expanded planned action scenario would include up to 2,066 foundations and 2,944 acres (12 km^2) of new scour protection and hard protection atop cables. Projects may also install more buoys and met towers. BOEM anticipates that structures would be added intermittently over an assumed 6- to 10-year period beginning in 2022, and that they would remain until decommissioning of each facility is complete (30 years).

Anthropogenic structures, especially tall vertical structures such as WTG and ESP foundations, alter local water flow at a fine scale, and could potentially result in localized impacts on sea turtle prey distribution and abundance (Section 3.3.1.1). Water flow typically returns to background levels within a relatively short distance from the structure. Tank tests, such as the one conducted by Miles et al. (2017), conclude that mean flows are reduced immediately downstream of a monopile foundation, but return to background levels within a distance that is dependent on the pile diameter. For foundations like those proposed by Vineyard Wind, background conditions would return approximately 328 feet (100 meters) away from each monopile foundation. Altered hydraulics can increase seabed scour and sediment suspension around foundations, but BMPs would be in place to minimize scour; therefore, sediment plumes, if any, would return to baseline conditions within a short distance.

The changes in fluid flow caused by the presence of an estimated 2,066 structures could also influence sea turtle prey species at a broader spatial scale. The existing physical oceanographic conditions in the geographic analysis area, with a particular focus on the Southern New England region, are described in Appendix E. Although waters on the OCS experience considerable vertical mixing throughout much of the year, an important seasonal feature influencing sea turtle prey is the cold pool, a mass of cold bottom water in the mid-Atlantic bight overlain and surrounded by warmer water. The cold pool forms in late spring and persists through summer, gradually moving southwest, shrinking, and warming due to vertical mixing and other factors (Chen et al. 2018). During summer, local upwelling and local mixing of the cold pool with surface waters provides a source of nutrients, influencing primary productivity of the ecosystem, which in turn influences finfish and invertebrates (Lentz 2017; Matte and Waldhauer 1984). While there is a high degree of uncertainty, the presence of many WTG structures could affect oceanographic and atmospheric conditions by reducing wind-forced mixing of surface waters and increasing vertical mixing of water forced by currents flowing around foundations (Carpenter et al. 2016; Schultze et al. 2020). During times of stratification (summer), increased mixing could possibly increase pelagic primary productivity in local areas. The ultimate effects on sea turtle prey species, and therefore sea turtles, of changes to oceanographic and atmospheric conditions caused by offshore structures are not known at this time, and they are likely to vary seasonally and regionally.

The presence of new structures could result in increased prey items for some sea turtle species. WTG and ESP foundations could increase the mixing of surface waters and deepen the thermocline, possibly increasing pelagic productivity in local areas (English et al. 2017). Additionally, hard-bottom (scour control and rock mattresses used to bury required offshore export cables) and vertical structures (i.e., WTG and ESP foundations) in a soft-bottom habitat can create artificial reefs, thus inducing the “reef effect” associated with higher densities and biomass of fish and decapod crustaceans (Causon and Gill 2018; Taormina et al. 2018). Invertebrate and fish assemblages may develop around these reef-like elements within the first year or two after construction (English et al. 2017). Although some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the reef effect results in increased productivity versus simply attracting and aggregating fish from the surrounding areas (Causon and Gill 2018). Recent studies have found increased biomass for benthic fish and invertebrates, and possibly for pelagic fish, sea turtles, and birds as well (Pezy et al. 2018; Raoux et al. 2017; Wang et al. 2019), indicating that offshore wind facilities can generate beneficial permanent impacts on local ecosystems, translating to increased foraging opportunities for sea turtle species (Section 3.3.1.1). The vertical WTG structures may also result in increased primary production and zooplankton, which provide forage for sea turtles and sea turtle prey species.

In the Gulf of Mexico, loggerhead, leatherback, green, Kemp's ridley, and hawksbill sea turtles have been documented in the vicinity of offshore oil and gas platforms, with the probability of occupation increasing with the age of the structures (Gitschlag and Herczeg 1994; Gitschlag and Renauld 1989; Hastings et al. 1976; Rosman et al. 1987). As such, sea turtles would be expected to use habitat between the WTGs as well as around structures for feeding, breeding, resting, and migrating for short periods, but residency times around structures may increase with the age of structures if communities develop on and around foundations. Although migrating sea turtles could make temporary stops to rest and feed during migrations, the presence of structures is not expected to result in noticeable changes to overall migratory patterns in sea turtles. Long-term, high-exposure, low-intensity impacts on foraging and sheltering are expected to be beneficial to sea turtles.

While the anticipated reef effect would result in beneficial effects on sea turtles, some potential exists for increased exposure to high-intensity risk of interactions with fishing gear that may lead to entanglement, ingestion, injury, and death. The presence of structures may concentrate recreational fishing around foundations, both personal and for-hire, and would also increase the risk of gear loss/damage. This could cause entanglement, and increase the potential for entanglement in both lines and nets leading to injury and mortality due to abrasions, loss of limbs, and increased drag leading to reduced foraging efficiency and ability to avoid predators (Berreiros and Raykov 2014; Gregory 2009; Vegter et al. 2014). Between 2016 and 2018, 186 sea turtles were documented as hooked or entangled with recreational fishing gear (Table 3.5-4). These data, provided by the Sea Turtle Stranding and Salvage Network, are collected by a network of federal, state, and permitted private partners to identify causes of morbidity and mortality of sea turtles to inform conservation, management, and recovery. The reef effect may result in attracting recreational fishing effort from inshore areas and attract sea turtles for foraging opportunities, resulting in a small increase in interactions between sea turtles and fisheries at WTG locations if both fishing and turtles are concentrated around the same foundations. Due to the high number of foundations in a wind development area, it is likely that recreational and for-hire fisheries would avoid overcrowding structures by dispersing effort across many WTG foundations. However, the risk of entanglement and hooking or ingestion of marine debris could slightly increase since both fishers and turtles may be attracted to the same areas.

Some level of sea turtle displacement out of the lease areas into areas with a higher potential for interactions with ships or fishing gear during the construction phases of future offshore wind development may occur (Appendix A Section A.8.6). Given the use of structures in the Gulf of Mexico, as described above, no long-term displacement would be expected. After construction, commercial and recreational fishing vessels may be displaced outside of the WDAs. The expanded planned action scenario would impact all fisheries and all gear types (Section 3.10). Bottom tending mobile gear is more likely to be displaced than fixed gear. The future offshore wind projects would be more likely to displace larger fishing vessels with small mesh bottom-trawl gear and mid-water trawl gear compared to smaller fishing vessels with similar gear types that may be easier to maneuver. If the area of effort were to change to areas adjacent to offshore wind projects, increased risk would not be expected beyond the current risk within wind areas due to the patchy distribution of sea turtles. In addition to displacement of fishing effort to areas outside of the WDA, some potential exists for a shift in gear types from fixed to mobile, or from mobile to fixed gear, due to displacement from the WDA. Although a potential for gear shifts exists due to a change in the location of fishing effort, the potential impact to sea turtles is uncertain. However, if such a shift in gear types would occur, it may result in a potential increase in the number of vertical lines in the water column if there is no commensurate reduction in fixed gear types to mobile gear. In such circumstances of a greater shift of mobile gear to fixed gear, there would be a potential increase in the number of vertical lines resulting in an increased risk of sea turtle interactions with fishing gear.

Increased vessel traffic: Vessel traffic associated with future offshore wind development poses a high-frequency, high-exposure collision risk to sea turtles in coastal waters when transiting to and from individual lease areas during construction, operations, and decommissioning. Propeller and collision injuries from boats and ships are common for sea turtles. Vessel strike is an increasing concern for sea turtles, especially in the southeastern United States, where development along the coast is likely to result in increased recreational boat traffic. In the United States, the percentage of strandings of loggerhead sea turtles attributed to vessel strikes increased from approximately 10 percent in the 1980s to a record high of 20.5 percent in 2004 (NMFS and USFWS 2007). Sea turtles are likely to be most susceptible to vessel collision in coastal waters, where they forage from May through November. Vessel speed may exceed 10 knots in such waters, and those vessels traveling at greater than 10 knots would pose the greatest threat to sea turtles (Hazel et al. 2007). As described under the Noise section above, at the peak of Project construction from 2022 to 2023, up to 230 vessels associated with offshore wind development along the East Coast may be operating in the geographic analysis area. However, this vessel traffic increase would be expected to result in only a small incremental increase in overall vessel traffic within the geographic analysis area for sea turtles. Further, collision risk would only be expected when Project vessels are transiting to and from the lease areas. Once in the lease areas, vessels would typically be stationary and no collision risk would be expected, but some transits between locations may also occur. This increased collision risk from transiting Project vessels has the potential to result in injury or mortality to individuals, but would not be expected to have stock or population-level impacts on sea turtles given their patchy distribution within the geographic analysis area. Further, the required measures to minimize potential vessel impacts to sea turtles that would be implemented during construction, operations, and decommissioning of future offshore wind facilities would further reduce the risk of injury and mortality (Appendix A Table A-5).

Climate change: Several sub-IPFs related to climate change, including increased storm severity and frequency; increased erosion and sediment deposition; ocean acidification; altered habitat, ecology, and migration patterns; increased disease frequency; development of protective measures such as seawalls and barriers; and increased sediment erosion and deposition have the potential to result in long-term, high-intensity risk to sea turtles as well as changes to nesting periods, changes in sex ratios of nestlings, and the elimination of potentially suitable habitat or access to potentially suitable habitat (Fuentes and Abbs 2010; Janzen 1994; Newson et al. 2009; Witt et al. 2010). However, future offshore wind development would not be expected to contribute to climate change impacts on sea turtles. A discussion of activities that contribute climate change IPFs are provided in Section A.8.1 in Appendix A.

3.5.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, sea turtles would continue to follow current regional trends and respond to current and future environmental and societal activities.

While the proposed Project would not be built as proposed under the No Action Alternative, BOEM expects ongoing activities and future offshore wind activities to have continuing temporary to permanent impacts on sea turtles, primarily through pile-driving noise, presence of structures, vessel traffic, commercial and recreational fisheries gear interactions, and climate change. BOEM anticipates that the impacts of ongoing activities, especially vessel traffic, commercial and recreational fisheries gear interaction, and climate change would be **moderate**. In addition to ongoing activities, reasonably foreseeable activities other than offshore wind development include increasing vessel traffic, new submarine cables and pipelines, channel deepening activities, and the installation of new towers, buoys, and piers (Table 3.5-1). BOEM anticipates that the impacts of reasonably foreseeable activities other than offshore wind would be **minor**. BOEM expects that the combination of ongoing activities and reasonably foreseeable activities other than offshore wind development to result in **moderate** impacts on sea turtles, driven primarily by increasing vessel traffic and commercial and recreational fisheries gear interactions.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area combined with ongoing activities and reasonably foreseeable non-offshore wind activities would result in **moderate** impacts due to the presence of structures and pile-driving noise. The majority of offshore structures in the geographic analysis area for sea turtles would be attributable to the offshore wind industry. The offshore wind industry would also be responsible for a majority of the impacts associated with new cable emplacement and EMF, but effects on sea turtles resulting from these IPFs would be localized and temporary, and would not be expected to be biologically significant.

The No Action Alternative would forgo pre- and post-construction monitoring, pile-driving monitoring, and vessel strike reporting that Vineyard Wind has committed to voluntarily perform, the result of which could provide an understanding of the effects of offshore wind development, benefit future management of sea turtles, and inform planning of other offshore developments. However, other ongoing and future surveys could provide similar data.

3.5.2. Consequences of Alternative A

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on sea turtles:

- The WTG foundation type used. The potential acoustic impacts on sea turtles differ among the WTG foundation types that Vineyard Wind would use: either Scenario 1 (100 monopiles and two ESP jacket foundations) or Scenario 2 (a combination of up to 90 monopiles and 12 jacket foundations). The jacket-type foundation would have a higher acoustic impact than the monopile foundation due to the increased risk of exposure because of the longer time required to install more piles (up to four 9.8foot [3-meter] pin piles per jacket) (Pyć et al. 2018).
- The monopile diameter. The potential acoustic impacts on sea turtles differ among the WTG monopile diameters that may be used. Vineyard Wind would use monopiles with a maximum diameter between 25 feet (7.5 meters) and 34 feet (10.3 meters). The acoustic modeling (Pyć et al. 2018) assessed two scenarios: the impacts associated with a monopile diameter of 34 feet (10.3 meters) and a monopile diameter of 30 feet (9 meters).
- The number of WTGs installed. The overall potential acoustic impacts on sea turtles differ among scenarios based on the total number of WTGs installed. Although the potential acoustic impacts of installing a single 14 MW turbine (34-foot-diameter [10.3-meter] monopile) are higher than installing a single 8 MW turbine (25-foot-diamter [7.5-meter] monopile), the overall impacts of using the larger turbines are expected to be lower due to the total duration of pile driving that would be required to install fewer piles (Pyć et al. 2018). (This assumes that Vineyard Wind would install the same number of jacket foundations under both scenarios.)
- The number of ESPs. Vineyard Wind would use either one approximately 800 MW ESP or two 400 MW ESPs. Impacts would be higher if Vineyard Wind used two ESPs due to the overall installation time required (1 day per ESP). (This assumes that Vineyard Wind would use the same foundation type under both scenarios.)

Aspects of the proposed Project design include the OECC, the WTG design selected (e.g., 8 MW, 14 MW), the exact placement and number of WTGs and ESPs, the final inter-array cable layout, and the construction schedule, which would be determined based on site assessment data, engineering requirements, and other factors. Although some variation is expected in the design parameters, the impact assessment in this section analyzes the maximum-case scenario.

Alternative A alone would likely result in temporary to permanent impacts (disturbance, displacement, injury, mortality, and reduction in prey base) that are expected to be generally localized and would not be expected to alter the overall character of the resource in the geographic analysis area for sea turtles. Some impacts would be adverse and some could be beneficial. Overall, the impacts of Alternative A alone are expected to range from **negligible** to **moderate** and could include potentially **moderate beneficial** impacts due to the presence of structures.

The analysis of impacts under the No Action Alternative, and references therein, applies to the following discussion of the Proposed Action. The most impactful IPFs would likely include pile-driving noise, which could cause noticeable temporary behavior impacts for 4 to 6 hours at a time during construction; increased vessel traffic, which could lead to injury and/or mortality; and the presence of structures, which would lead to permanent impacts that may be either adverse or beneficial. Other IPFs would likely contribute impacts of lesser intensity and extent, and would occur primarily during construction, but also during operations and decommissioning. For additional details, see Table 3.5-1.

Accidental releases: The incremental impacts of Alternative A from accidental releases of hazmat and trash/debris would not increase the risk beyond that described under the No Action Alternative. Further, Alternative A would comply with the USCG requirements for the prevention and control of oil and fuel spills and would implement proposed BMPs for waste management and mitigation as well as marine debris awareness training for Vineyard Wind 1 Project personnel, reducing the likelihood of an accidental release. In the unlikely event of an accidental spill, hydrocarbons may negatively impact sea turtles within 20 to 50 miles (32 to 80 kilometers) of the spill. BOEM expects the potential impacts of exposure to be sublethal based on the low concentration of hydrocarbons that would be expected during a potential sea turtle exposure event. The NOAA BA and associated BO contain further details on the oil spill model (BOEM 2019d; NMFS 2020b). Additionally, Vineyard Wind would have an Oil Spill Response Plan in place that would decrease potential impacts from spills. Therefore, due to the unlikelihood of an oil spill, the sublethal level of impact, and the implementation of an Oil Spill Response Plan, potential temporary negative impacts on sea turtles from accidental oil (or other chemical) spills would result in **negligible** impacts, if any, due to the rare, brief, and highly localized nature of accidental releases.

While the significance level of impacts would remain the same, BOEM could further reduce impacts to help alleviate potential mortality and injury with the following mitigation measure conditioned as part of the COP approval (Appendix D), which is to provide Project personnel with informational training on proper storage and disposal practices to reduce the likelihood of accidental discharges.

In context of reasonably foreseeable environmental trends, combined impacts of accidental releases on sea turtles from ongoing and planned actions, including Alternative A, are expected to be temporary and highly localized due to the likely limited extent and duration of a release, resulting in **negligible** impacts. The contribution from future offshore wind and Alternative A would be a low percentage of the overall accidental release risk from ongoing activities.

EMF: Both the OECC and inter-array systems are AC cables, and Vineyard Wind would bury all cables at a depth of 5 to 8 feet (1.5 to 2.5 meters). Modeled and measured magnetic field levels from various existing undersea power cable results indicate that AC cables buried to a depth of 3.2 feet (1 meter) would emit field intensities less than 0.05 µT to 82 feet (25 meters) above the cable, and 79 feet (24 meters) along the seafloor. Comparison of these results with sensitivity levels for sea turtles suggests that turtles are capable of sensing magnetic fields from undersea cables (Normandeau et al. 2011). Although desktop studies suggest that sea turtles are capable of sensing magnetic fields from submarine cables, there is little evidence that these small EMFs along a cable corridor would result in impacts on turtle navigation or orientation (Normandeau et al. 2011; Papi et al. 2000). Additionally, no nesting beaches, critical habitat, or other biologically important habitats have been identified in the Proposed Action area that could result in harm to sea turtles should any minor behavioral response occur and animals leave the immediate area. The potential long-term impacts on sea turtles exposed to magnetic fields from cables installed under the Proposed Action are not expected to be measurable. While EMFs associated with the proposed Project's submerged cables would be detectable by sea turtles, non-measurable, **negligible** impacts would be expected due to the localized nature of EMFs along the cables near the seafloor, the wide ranges of sea turtles, and appropriate shielding and burial depth. EMF from multiple cables would not overlap, even for multiple cables within a single OECC.

In context of reasonably foreseeable environmental trends, the combined impacts of EMF on sea turtles from ongoing and planned actions, including Alternative A, are expected to be long-term, but highly localized, resulting in overall **negligible** impacts.

Light: The proposed Project's incremental contribution would be lighting of up to 100 WTGs and two ESPs, all of which would be lit with navigational and FAA hazard lighting. Per BOEM guidance (2019a) and outlined in the COP (Section 3.1.1, Volume I; Epsilon 2020a), each WTG would be lit with two FAA "L-864" aviation red flashing obstruction lights on top of the nacelle, adding up to 200 new red flashing lights to the offshore environment where none currently exist. Should the Proposed Action involve the use of taller 14 MW WTGs, additional mid-mast lighting would be required, resulting in three FAA aviation red flashing obstruction lights per WTG for a total of 285 (57 x 5 = 285) red flashing lights on the OCS where none currently exist. Additionally, marine navigation lighting would consist of multiple flashing yellow lights on each WTG and on the corners of each ESP. The Vineyard Wind 1 Project is proposing to use an Aircraft Detection Light System (ADLS). The proposed use of red flashing lights would minimize the potential for disorientation effects to adult and juvenile sea turtles (Orr et al. 2013) and the proposed use of ADLS would substantially reduce the amount of light emitted into the environment. Vessel lights during construction, operations, and decommissioning would be minimal and likely limited to vessels transiting to and from construction areas. The BA (BOEM 2019d) and associated BO (NMFS 2020b) analyzes the potential effects of the proposed lighting on sea turtles. Based on the intermittent nature of the proposed lighting and the lack of evidence that offshore platform illumination leads to impacts on sea turtles, BOEM expects that potential long-term impacts of lighting on sea turtles, if any, would be **negligible**.

While the significance level of impacts would remain the same, BOEM could further reduce impacts with the following mitigation measures conditioned as part of the COP approval (Appendix D):

- Use of red flashing FAA hazard lighting to decrease the likelihood of disorienting effects to adult and juvenile sea turtles.
- Use of ADLS to minimize the amount of time that FAA hazard lighting is visible to reduce potential disorienting effects.

In context of reasonably foreseeable environmental trends, the combined lighting impacts on sea turtles from ongoing and planned actions are expected to be **negligible**. Under the expanded planned action scenario, up to 2,021 turbines and 45 ESPs would have lights, and these would be incrementally added over time beginning in 2022 and continuing through 2030 on the OCS along the East Coast. Lighting of turbines and other structures would be minimal (navigation and aviation hazard lights) and in accordance with BOEM (2019a) guidance. Ongoing and future non-offshore wind activities are expected to cause permanent impacts, primarily driven by light from onshore structures and short-term, localized impacts from vessel lights.

New cable emplacement and maintenance activities: Sea turtles in the WDA would likely be foraging, since the benthic community in the WDA includes several prey items including amphipods and other crustaceans, crabs, gastropods, and bivalves (BOEM 2014b). The Proposed Action's incremental contribution of up to 328 acres (1.3 km^2) of seafloor disturbance by cable installation and up to 69 acres (0.3 km^2) affected by dredging prior to cable installation would result in turbidity effects that have the potential to temporarily affect some sea turtle prey species, including benthic mollusks, crustaceans, sponges, sea pens, and crabs. Based on the assumptions in Appendix A Table A-4, cable emplacement associated with the South Fork Wind Project (OCS-A 0486) would overlap in time with the Proposed Action in 2022. However, given the localized nature of these impacts, impacts associated with the emplacement of South Fork Wind's export and inter-array cabling would not overlap spatially with the Proposed Action, and no additional impacts would be expected. 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 also generate additional water quality impacts. Construction and installation would affect a small percentage of the available foraging habitat, and recolonization and recovery to pre-construction species assemblages is expected within 2 to 4 years (Van Dalfsen and Essink 2001), but may be as rapid as 100 days (Dernie et al. 2003b) given the similarity of nearby habitat and species. Because impacts on foraging habitat are mostly temporary and localized, and individual sea turtles, if present, would be expected to successfully forage in nearby areas not affected by increased sedimentation, only non-measurable **negligible** impacts, if any, on individual sea turtles would be expected (NOAA 2020i).

In context of reasonably foreseeable environmental trends, the combined cable emplacement impacts on sea turtles from ongoing and planned actions, including Alternative A, 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.

Noise: Studies indicate that hearing in sea turtles is generally confined to lower frequencies, below 2,000 Hz, with the range of highest sensitivity between 100 and 700 Hz (Dow Piniak et al. 2012). Current data for species-specific hearing range frequencies are summarized in Table 3.5-5 in Appendix B. Behavioral studies in loggerhead sea turtles indicated startle responses were elicited at frequencies between 50 and 800 Hz (Martin et al. 2012). Pyć et al. (2018) conducted acoustic exposure modeling for sea turtles during pile driving of the two foundation types (monopile and jacket piles) under two possible design scenarios (a combination of monopile and jacket foundations and monopiles only) and three levels of attenuation (0 dB, 6 dB, and 12 dB), using the most recent available sightings data (Table 3.5-3). The 0 dB level was modeled as a reference point to evaluate the effectiveness of the proposed sound reduction technology (e.g., Hydro-sound Damper, bubble curtains, or similar). Although sound reduction would aim for 12 dB, BOEM considers 6 dB the maximum-case scenario[11] in this FEIS. The BA and associated BO provide detailed discussions of the threshold criteria used for deriving sea turtle noise exposure estimates (BOEM 2019d, NMFS 2020b).

When comparing threshold criteria between foundation types, the maximum radial distance to the injury threshold for sea turtles would be largest during 34-foot (10.3-meter) monopile installation at 2,536.1 feet (773 meters), or an area of 470 acres (1.9 km^2). The radial distance to the injury threshold during jacket installation would be 1,738.8 feet (530 meters), or an area of 222 acres (0.9 km^2) and would occur for 12 days for 14 hours per day (Pyć et al. 2018). The largest distance to the behavioral harassment threshold would occur during monopile installation at 7,805 feet (2,379 meters) or 5,832 acres (23.6 km^2). The behavioral harassment threshold would reach 6,378 feet (1,944 meters) from the pile during jacket installation with an area of 2,941 acres (11.9 km^2) (Pyć et al. 2018). The cumulative sound exposure level is the dominant threshold. The maximum-case scenario is defined by the highest number of individual sea turtles predicted to exceed the injury threshold criteria with 6 dB attenuation.

[11] BOEM assumed the 6 dB reduction is the maximum-case scenario since the type of sound reduction system that could be evaluated for past effectiveness during use is not yet identified.

Scenario 1 with two piles installed per day had the highest number of sea turtles estimated to be exposed to the injury threshold, and thus is considered the maximum-case scenario. Table 3.5-7 provides the exposure estimates for injury and behavioral harassment for sea turtles.

Kraus et al. (2016b) indicate higher density (0.8725 animal per 24,710 acres [100 km^2] in the fall and 0.63 animal per 24,710 acres [100 km^2] in the summer) compared to densities estimated in the acoustic model in the fall (0.0274 animal per 24,710 acres [100 km^2]) and summer (0 animal per 24,710 acres [100 km^2]) (Pyć et al. 2018). Thus, the exposure of leatherback turtles to pile-driving noise could be greater than that estimated in the acoustic model. SPUE data indicate that loggerhead, leatherback, and unidentified sea turtles are most susceptible to impacts from pile driving during the fall, when expected abundances in the WDA are relatively moderate to high (September through November) (Appendix E Figures E.5-5 through E.5-8; Right Whale Consortium 2018). Trained observers would monitor the zone immediately around vessels used in pile driving and would prohibit pile driving when a sea turtle was present within the 500-foot (152-meter) clearance zone surrounding the vessel. There is a potential risk of PTS and harassment to sea turtles from pile driving due to the large radial distance to this threshold and maximum impact over the 102 days that pile driving may occur. Behavioral responses to pile-driving activities could range from a startle with immediate resumption of normal behaviors to complete avoidance of the area, and could also include changes in diving patterns or changes in foraging behavior (NMFS 2020b). Sea turtles foraging, migrating, or resting within 1.6 miles (2.7 kilometers) of the pile being driven are expected to temporarily stop these behaviors and make evasive movements (changes in diving or swimming patterns) until they are outside the area where noise is elevated above 166 dB re 1 µPa RMS (NMFS 2020b). Given that the piles would be installed in an open ocean environment with no impediments to movement, sea turtles are expected to be able to avoid the ensonified area (NMFS 2020b). Depending on how close the individual is to the pile being driven, this could involve swimming up to 1.6 miles (2.7 kilometers). The turtle may experience physiological stress during this avoidance behavior, but this stressed state is expected to dissipate once the sea turtle is outside the ensonified area. Given the vast distances that sea turtles are capable of migrating, additional energy expenditure by individuals to avoid pile-driving activities would be **negligible**. Assuming the model predictions are accurate, and considering that sea turtles would exhibit an avoidance response before receiving the 24-hour exposures in Table 3.5-6, BOEM anticipates unavoidable, **moderate** temporary impacts on individual sea turtles from pile driving, given that pile-driving activities would occur over the course of a year**.** However, these **moderate** effects are expected to occur only in a very small number of turtles, and no population-level effects are expected from the potential temporary behavioral disturbance associated with pile-driving activities. There have been no documented sea turtle mortalities associated with pile driving, and sea turtle anatomy may make them resistant to percussive shock waves (Madin 2009). Based on the low densities of sea turtles in the WDA, soft-starts to allow turtles to leave the area before injurious levels are received, and the implementation of monitoring zones and clearance zones, mortal injury would not be expected to result from the anticipated **moderate** impacts associated with pile driving.

BOEM expects that helicopters transiting to the WDA would fly at altitudes above those that would cause behavioral responses from sea turtles except when flying low to inspect WTGs or when taking off and landing on the SOV. While helicopter traffic may cause some short-term behavioral reactions in sea turtles (BOEM 2017; NSF and USGS 2011; Samuel et al. 2005), these brief responses would be expected to dissipate once the aircraft has left the area. BOEM expects these impacts to be temporary, short-term, and **negligible,** resulting in minimal energy expenditure.

Sea turtles would be able to hear the continuous underwater noise of operational WTGs. However, based on the results from Thomsen et al. (2015) and Kraus et al. (2016b), the received SPLs generated by the WTGs are expected to be at or below ambient levels at relatively short distances (164 feet [50 meters]) from the foundations (Miller and Potty 2017). The BA and associated BO provide detailed discussions on the continuous underwater noise produced from the operation of wind turbines (BOEM 2019d; NMFS 2020b). Given that WTG noise would be at or below ambient within a short distance from WTG bases, non-measurable **negligible** impacts, if any, would be expected.

G&G surveys associated with the inspection of Project cables and foundations after installation and with site clearance activities associated with decommissioning may result in impacts on sea turtles from survey noise. Noise from G&G surveys during inspection and/or monitoring of cables may occur during the proposed Project. G&G survey effort resulting from these post-construction surveys would be shorter in duration and smaller in scope than site investigation surveys in WDAs. The HRG surveys would use only electromechanical sources such as boomer, sparker, and chirp sub-bottom profilers; side-scan sonar; and multi-beam depth sounders. Acoustic signals from electromechanical sources other than the boomer and sparker are not likely to be detectable by sea turtles. Boomers and sparkers have an operating frequency range of 200 Hz to 16 kHz and could be audible to sea turtles; however, it has very short pulse lengths (120, 150, or 180 microseconds) and a very low source level, with a 180 dB radius of less than 5 meters (16 feet) (BOEM 2014a). As such, BOEM believes that injury is unlikely given the PTS distances and the brief duration of the acoustic impacts. Because the potential for injury is small, very brief, and temporary, BOEM anticipates **minor** impacts on sea turtles from HRG noise.

The fall pipe technique used for placement of scour protection may include the use of an ROV. Data for underwater sound levels from ROVs are limited and highly variable. Estimates from one study indicated levels with thrusters off were greater than 130 dB, and levels with all thrusters on were greater than 160 dB (Roundtree et al. 2002). BOEM does not expect these noise levels to cause injury, but they could cause temporary behavioral modification to sea turtles, with a return to normal behavioral patterns after Project construction and installation. As such, BOEM anticipates these temporary impacts would be **minor**. According to the Navigational Risk Assessment (NRA; COP Volume III, Appendix III-I; Epsilon 2020b), current vessel traffic in the WDA and surrounding waters is relatively high, and vessel traffic within the Vineyard Wind WDA is relatively moderate (Section 3.4.7 in the NRA). The NRA for the WDA indicates that the maximum number of vessels during construction would be 46 per day (with an average of 25 per day) (COP Volume III, Appendix III-I; Epsilon 2020b). This volume of traffic would vary monthly depending on weather and Proposed Action activities. During the period of maximum activity, Proposed Action construction would generate an average of 18 construction vessel trips per day in or out of construction ports. In maximum conditions, this could theoretically include up to 46 trips in a single day, including up to 4 trips per day to or from secondary ports, with the remainder originating or terminating at the New Bedford MCT, compared to the current 25 daily vessel trips measured via AIS in 2011 (COP Volume III, Appendix III-I; Epsilon 2020b). The frequency range for vessel noise overlaps with sea turtles' known hearing range and would therefore be audible. However, Hazel et al. (2007) suggest that sea turtles' ability to detect approaching small boats is primarily vision-dependent, not acoustic. Sea turtles may respond to vessel approach and/or noise with a startle response (diving or swimming away) and a temporary stress response (NSF and USGS 2011). BOEM anticipates the potential temporary effects of noise from construction and installation vessels on disturbance of sea turtles to be localized, short-term, and therefore **minor**, with individuals completely recovering after construction and installation.

As outlined above, no serious injury or mortality is expected to occur as a result of pile-driving activities. While the significance level of impacts would remain the same, BOEM could further reduce impacts to help alleviate potential impacts on sea turtles with the following mitigation measures conditioned as part of the COP approval (Appendix D) by BOEM that also includes the mitigation, monitoring, and reporting requirements proposed by Vineyard Wind and required in the September 11, 2020 BO. The mandatory measures included in the BO have been designed to reduce the amount and extent of ESA-listed species take related to pile-driving noise. The use of noise-reduction technologies during all pile-driving activities to ensure a minimum attenuation of 6 dB would reduce the area impacted by noise during construction. The specific technologies have not yet been selected; potential options include a Noise Mitigation System, Hydro-sound Damper, Noise Abatement System, a bubble curtain, or similar (Pyć et al. 2018). In addition to the use of one sound attenuation system, Vineyard Wind has committed to complete sound field verification and to have a second attenuation technology on hand, which would be deployed if sound field verification demonstrates a need for greater attenuation. The use of PSOs during pile-driving and HRG survey activities would reduce the potential noise impacts by establishing and maintaining exclusion zones to minimize sea turtle exposure to injurious levels of noise. The detectability of sea turtles is dependent upon metrological conditions, PSO training, PSO fatigue, and animal behavior. PSO training and shift requirements, as detailed in Appendix D, would increase the ability of PSOs to detect listed species. Vineyard Wind would also submit an alternative monitoring plan to ensure the ability to maintain exclusions zones during adverse monitoring conditions.

- Implementation of pile-driving noise reduction technologies to achieve a reduction of noise impacts
- Pile-driving noise monitoring to ensure compliance with required noise reductions
- Refinement of exclusion zones based on field measurements
- Daily preconstruction surveys to ensure that marine mammals and sea turtles are not present in the area during pile driving
- Use of PSOs to establish clearance zones prior to commencing pile-driving activities
- Pile driving time of day restrictions to ensure that all clearance zones are maintained

- Daily and weekly reporting of sea turtles observed, if any, during pile-driving operations

Impacts associated with decommissioning would be similar to the impacts of the construction phase. WTG and ESP foundation and scour protection removal would have the same temporary habitat impacts as construction (with the exception that there would be no pile driving). Decommissioning activities include removing Project components, including WTGs and ESPs, to 15 feet (4.6 meters) below the mudline (Section 2.1.1.3). The portion buried below 15 feet (4.6 meters) would remain, and Vineyard Wind would refill the depression with sediment. Decommissioning impacts would include noise emitted from underwater acetylene cutting torches, mechanical cutting, high-pressure water jets, and vacuum pumps. SPLs are not available for these types of equipment, but are not expected to be higher than construction vessel noise (generally between 150 and up to 180 dB re 1 µPa; Pangerc et al. 2016). In addition, Vineyard Wind proposes HRG and ROV surveys for site clearance activities. As discussed in the BO, given the very small ensonified area and brief duration of noise impacts, any effects on sea turtles are expected to be limited, brief startle responses and associated behavior interruptions associated with HRG surveys. The most likely and extensive effects of HRG surveys on sea turtles would be behavioral responses. Vineyard Wind would also remove the scour protection and hard protection atop cables. Although some of the decommissioning activities (e.g., acoustic impacts and increased levels of turbidity) may cause sea turtles to avoid or leave the Proposed Action area, this disturbance would be short-term and temporary. Further, avoidance would be limited to very small areas where sound levels exceed thresholds and only during noise-producing activities. BOEM anticipates potential temporary impacts on sea turtles during decommissioning to be **minor**, with individuals returning to the area following decommissioning activities.

In context of reasonably foreseeable environmental trends, the combined impacts due to various anthropogenic noise sources on sea turtles from ongoing and planned actions, including Alternative A, are expected to range from **negligible** to **moderate**. The **moderate** temporary impacts that would be expected to result from the pile driving of offshore wind projects would be added to existing noise levels beginning in 2022 and continuing through 2030 along the East Coast. The IPF would be removed from the environment once pile driving stops and the behavior of sea turtles is expected to return to normal. However, the effects of PTS may be permanent. Although permanent hearing impairment could occur, there is evidence that sea turtles rely upon other senses including magnetic orientation (Avens and Lohmann 2003; Light et al. 1993; Putman et al. 2015) and vision (Avens and Lohmann 2003; Narazaki et al. 2013) Affected individuals may not have to adjust their life history strategies in response to PTS, but the consequences of hearing impairment in sea turtles are difficult to study and are not well understood. However as discussed above and in the BO (NMFS 2020b), PTS is not expected to occur as a result of the proposed Project.

Port expansion: No port expansion activities are anticipated for the Proposed Action. As such, the Proposed Action would not be expected to appreciably contribute to impacts on sea turtles.

Presence of structures: The various types of impacts on sea turtles that could result from the presence of structures, such as entanglement and gear loss/damage, fish aggregation and habitat conversion, and avoidance/displacement, are described in detail in Section 3.5.1. As previously discussed, the proposed Project would result in a conversion of soft-bottom habitat to hard-bottom due to scour protection over the life of the proposed Project. Using the assumptions in Appendix A Table A-4, there could be up to approximately 2,944 acres (12 km^2) of new hard protection. Of this area, only 151 acres (0.6 km^2) would result from the proposed Project, and the remainder would result from other offshore wind projects in the geographic analysis area. Of the estimated 2,066 structures, 102 would result from the proposed Project. The structures and scour/cable protection, and the potential consequential impacts would remain at least until decommissioning of each facility is complete (30 years). As described above, structures associated with the Vineyard Wind 1 Project would be expected to provide some level of reef effect and may result in long-term, **minor beneficial** impacts on sea turtle foraging and sheltering; however, long-term, **minor** impacts could occur as a result of increased interaction with active or ghost fishing gear and/or interruptions of important life history behaviors. The reef effect, and associated increase in fish biomass as described under the No Action Alternative, could increase recreational fishing effort in the WDA. Fishing in and around turbine foundations may increase marine debris from fouled fishing gear in the area. Current threats to sea turtles include fishing gear and ingestion of marine debris. Entanglement and ingestion of marine debris is not considered a new impact-producing factor, but rather a change in the distribution of this factor if inshore fishing effort is moved offshore. A slight increase in concentrations of fishing activity and sea turtles may occur around WTG foundations, therefore the impacts of fishing on sea turtles due to potential reef effects may occur in a slightly different location near the WTG foundations. However, any detectable increase in interactions with fishing gear is not expected; therefore, BOEM anticipates impacts to be **negligible**. Although impacts are expected to be **negligible**, effects around the WTG foundations resulting from the redistribution of fishing effort may be measurable.

While the significance level of impacts would remain the same, BOEM could further reduce impacts to help alleviate potential mortality and injury with the following mitigation measures conditioned as part of the COP approval (Appendix D): requirement for annual remotely operated underwater vehicle surveys, reporting, and monofilament and other fishing gear cleanup around WTG foundations.

While the abandoned fishing gear would be removed, the potential for entanglement and/or hooking associated with active commercial or recreational fishing gear would still exist, but be greatly reduced over the lifetime of the Project. Overall, the presence of structures associated with the Proposed Action would be expected to result in **negligible** to **minor** impacts on sea turtles, as well as potential **minor beneficial** impacts (Table 3.5-1).

In context of reasonably foreseeable environmental trends, the combined impacts arising from the presence of structures on the Atlantic OCS from ongoing and planned actions, including Alternative A, would be expected to range from **negligible** to **moderate,** and may include **moderate beneficial** impacts due to the large number of structures.

Increased vessel traffic: Propeller and collision injuries from boats and ships are common in sea turtles. Sea turtles are likely to be most susceptible to vessel collision in coastal waters, where they forage, when vessels transit from ports. Vessel speed may exceed 10 knots during such transits, and those vessels traveling at greater than 10 knots would pose the greatest threat to sea turtles (Hazel et al. 2007). Additional information on sea turtle vessel strikes and potential for injury is included in the Vineyard Wind BO (NMFS 2020b). Construction and installation vessels would range in size from 66 to 98 feet (20 to 30 meters) to 394 to 732 feet (120 to 223 meters), with operational speeds from 10 to 25 knots. During the proposed Project's most active construction period, Vineyard Wind estimates that a maximum of approximately 46 vessels could operate simultaneously within the WDA or OECC. In an extreme case, all 46 of these vessels could need to travel to or from New Bedford or a secondary port in the same day; however, Vineyard Wind estimates that activities during the proposed Project's most active period would typically generate 18 vessel trips per day to or from ports. The maximum number of vessels involved in the proposed Project at any one time is highly dependent on the Project's final schedule, the final design of the Project's components, and the logistics solution used to achieve compliance with the Jones Act (COP Volume III, Section 7.8 and Appendix III-I; Epsilon 2020b). Vessel traffic associated with the proposed Project poses a high frequency, high exposure collision risk to sea turtles in coastal waters. However, the Proposed Action would be expected to result in only a small incremental increase in vessel traffic, with a peak during proposed Project construction. Based upon the analysis provided in the BO (NMFS 2020b), there are a total of 54,305 annual vessel trips through the WDA and OECC. Using this baseline vessel traffic in the area, the proposed Project would result in 4.7, 1.6, and 4 percent annual increases in vessel traffic during construction, operations, and decommissioning, respectively (NMFS 2020b). However, the NRA (COP Volume III, Appendix III-I; Epsilon 2020b) found that no significant disruption of normal traffic patterns is anticipated in the WDA associated with the proposed Project.

Vineyard wind anticipates that WTG and ESP components, as well as offshore export cables would be shipped from overseas ports, either directly to the WDA or through a U.S. port. A total of approximately 122 vessel round trips, with approximately 5 round trips per month are anticipated over the 2-year construction schedule. These estimates are based upon the installation of 100 WTGs and represent the maximum-case scenario. It is expected that these vessels would follow the major navigation routes and would be making similar trips to U.S. ports in the absence of the proposed Project (Michael Clayton, Pers. Comm., July 23, 2020).

In addition to increased vessel traffic associated with Project vessels, the reef effect due to the presence of structures, as described above, could draw recreational fishing effort to the WDA from inshore areas. However, the overall interaction between sea turtles and fisheries resulting from increased effort offshore could locally change the overlap in recreational fishing effort and sea turtle distributions around individual WTG foundations in the WDA. However, as shown in Appendix E Figures E.5-5 through E.5-8, sea turtles are not more abundant in the WDA than in surrounding areas and no detectable increase in interactions between fishing and sea turtles in this area is expected. Additionally, recreational vessels tend to be in neutral while fishing near structures and engaging engines primarily to move away from structures, making collisions very unlikely.

While the significance level of impacts would remain the same, BOEM could further reduce impacts to help alleviate potential mortality and injury with the following mitigation measures conditioned as part of the COP approval (Appendix D) by BOEM that also includes the mitigation, monitoring, and reporting requirements proposed by Vineyard Wind and required in the September 11, 2020 BO. The mandatory measures included in the BO have been designed to reduce the amount and extent of ESA-listed species take related to vessel strike.

- Requirement for vessel strike avoidance procedures and protected species reporting to ensure vigilance by vessel crews during transit
- Requirement for vessel observers to monitor a vessel strike avoidance zone around Project vessels
- Use of AIS to monitor the number of Project vessels, traffic patterns, and Project vessel compliance with required speed restrictions

Given the implementation of Project-specific measures, including the use of PSOs, vessel speed restrictions, and the maintenance of turtle avoidance buffers, BOEM anticipates that vessel strikes as a result of Alternative A alone would be low and that impacts on sea turtle individuals through this IPF would likely be **minor,** and as such, no population-level impacts would be expected. As discussed in the BO, an estimated take of 39 sea turtles is expected over the life of the Project (NMFS 2020b).

In context of reasonably foreseeable environmental trends, the combined vessel traffic impacts on sea turtles from ongoing and planned actions, including Alternative A, could result in **moderate** impacts due to injury or mortality to individuals, depending on the exposure duration. However, BOEM does not expect the viability of sea turtle populations to be affected.

Climate change: The surveying, construction, and decommissioning activities associated with the proposed Project would produce GHG emissions that can be assumed to contribute to climate change; however, these contributions would be small (i.e., 6,990 metric tons) compared with the aggregate global emissions. The impact of GHG emissions on sea turtles from the Project would not be detectable. Given that the Proposed Action would produce less GHG emissions than similarly sized fossil-fuel-powered generating stations, the effects associated with the expected reduction in GHG emissions would be expected to result in long-term, low intensity, beneficial impacts on sea turtles.

Other considerations: For temporary impacts, including the effects of pile-driving noise and new cable emplacement, it is likely that a portion, possibly the majority, of such impacts from future activities would not overlap in time with the temporary impacts of the Proposed Action. However, some IPFs that can cause temporary impacts can also cause long-term to permanent impacts.

In summary, construction, installation, and decommissioning of Alternative A alone would have **negligible** to **moderate** adverse impacts and could include potentially **minor beneficial** impacts. Adverse impacts are expected to result mainly from pile-driving noise and increased vessel traffic. Beneficial impacts are expected to result from the presence of structures. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.5.1.2.

In context of other reasonably foreseeable environmental trends in the geographic analysis area, impacts of individual IPFs resulting from planned actions, including Alternative A, would range from **negligible** to **moderate,** and may include **moderate beneficial** impacts. Considering all the IPFs together, BOEM anticipates that the impacts from ongoing and planned actions, including Alternative A, would result in **moderate** impacts on sea turtles in the geographic analysis area. The main drivers for this impact rating 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. The Proposed Action would contribute to the overall impact rating primarily through pile-driving noise and the presence of structures. Thus, the overall impacts on sea turtles would likely be **moderate** because a notable and measurable adverse impact is anticipated, but the resource would likely recover completely when the impacting agents are removed and remedial or mitigating actions are taken.

While the significance level of impacts would remain the same, BOEM could further reduce impacts with the following mitigation measures conditioned as part of the COP approval by BOEM that also includes the mitigation, monitoring, and reporting requirements proposed by Vineyard Wind and required in the September 11, 2020, BO. The mandatory measures included in the BO have been designed to reduce the amount and extent of ESA-listed species take related to pile-driving noise and vessel strike. A complete list of monitoring and mitigation measures relative to sea turtles is provided in Appendix D.

- Provide Project personnel with informational training on proper storage and disposal practices to reduce the likelihood of accidental discharges.
- Use red flashing FAA hazard lighting to decrease the likelihood of disorienting effects to adult and juvenile sea turtles.
- Use ADLS to minimize the amount of time that FAA hazard lighting is visible to reduce potential disorienting effects.
- Use Project lighting reductions to minimize the amount of light to reduce potential attraction to Project vessels, WTGs and ESPs.
- Implement pile-driving noise reduction technologies to achieve a reduction of noise impacts.
- Monitor pile-driving noise to ensure compliance with required noise reductions.
- Refine exclusion zones based on field measurements.
- Perform daily preconstruction surveys to ensure that marine mammals and sea turtles are not present in the area during pile driving.
- Use PSOs to establish clearance zones prior to commencing pile-driving activities.
- Use pile driving time of day restrictions to ensure that all clearance zones are maintained.
- Report—daily and weekly—sea turtles observed, if any, during pile-driving operations.
- Requirement for annual remotely operated underwater vehicle surveys, reporting, and monofilament and other fishing gear cleanup around WTG foundations.
- Requirement for vessel strike avoidance procedures and injured/dead protected species reporting to ensure vigilance by vessel crews during transit.
- Requirement for vessel to designate a crew person to monitor for sea turtles to avoid vessel strikes.
- Use AIS to monitor Project vessel compliance with required speed restrictions.

3.5.3. Consequences of Alternatives C, D1, D2, and E

Alternative C would relocate six of the northernmost WTG locations to the southern portion of the WDA primarily for the purpose of reducing visual impacts and minimizing conflicts with commercial fishing boats. BOEM does not expect that Alternative C would appreciably change the expected potential impacts on sea turtles because the number of turbines would remain the same and the southern portion of the WDA does not include areas with substantially higher densities of sea turtles.

Under Alternative D1, the total acreage of the WDA could increase by 22 percent (16,603 acres [67 km^2]) to achieve wider spacing between WTGs. Alternative D2 would align WTGs in an east-west orientation with a 1-nautical-mile spacing between all turbines to allow greater spacing between WTG rows, which would facilitate the established practice of mobile and fixed-gear fishing vessels. HRG surveys would be required as part of pre-construction Project activities under these alternatives, and some localized, temporary, acoustic impacts may occur. The HRG surveys would use only electromechanical sources such as boomer, sparker, and chirp sub-bottom profilers; side-scan sonar; and multi-beam depth sounders. Acoustic signals from electromechanical sources other than the boomer and sparker are not likely to be detectable by sea turtles. Boomers and sparkers have an operating frequency range of 200 Hz to 16 kHz and could be audible to sea turtles; however, it has very short pulse lengths (120, 150, or 180 microseconds) and a very low source level, with a 180 dB radius of less than 5 meters (16 feet) (BOEM 2014a). As such, BOEM believes that injury is unlikely given the PTS distances and the brief duration of the acoustic impacts. Further, individuals are expected to fully recover following the brief exposure to sounds associated with HRG surveys. While there is some potential for disturbance and behavioral avoidance in the vicinity of HRG surveys, no biologically significant impacts would be expected. During operations and maintenance, Alternatives D1 and D2 would increase the total length of inter-array cables compared to the Proposed Action. BOEM anticipates this difference to increase the potential for long-term EMF-related effects. Since the level of potential impacts from EMF on sea turtles is not well studied, BOEM does not know the extent of any additional long-term impacts associated with additional inter-array cabling required under these alternatives. BOEM anticipates that all other expected potential impacts associated with Alternatives D1 and D2 would not be measurably different from those anticipated under Alternative A and would not change the anticipated impact rating.

Under Alternative E, there would be a 16 percent reduction in the number of WTGs (assuming the installation of no more than 84 WTGs), which would translate into a reduction of pile-driving days, vessel traffic, duration of acoustic impacts, and fewer impacts on water quality and the benthic environment. Additionally, there would be a reduction in WTG and ESP scour protection, inter-array cable, and inter-array cable protection. As such, BOEM anticipates a decrease in potential impacts on sea turtles during construction and installation, operations and maintenance, and decommissioning. However, BOEM anticipates impacts on sea turtles overall would not be measurably different from those anticipated under Alternative A. Should larger WTGs be used, a greater reduction in anticipated impacts would be expected, but these impacts would not be expected to be measurably different than those described under Alternative A, and would not change the anticipated impact rating. BOEM anticipates the impacts resulting from individual IPFs associated with Alternatives C, D1, D2, or E to have potential **negligible** to **moderate** impacts and potential **minor beneficial** effects on sea turtles, and to not be measurably different from those anticipated under Alternative A.

In context of reasonably foreseeable environmental trends, the combined impacts of ongoing and planned actions, including Alternatives C, D1, D2, or E would be similar to those described under Alternative A (with impacts from individual IPFs ranging from **negligible** to **moderate** and may include **moderate beneficial** impacts). While Alternatives D1 and D2 may be slightly more impactful to sea turtles than Alternative A, and Alternative E may be slightly less impactful to sea turtles, the impacts under Alternatives C, D1, D2, and E would be similar to those impacts described under Alternative A. The overall impacts on sea turtles within the geographic analysis area of Alternatives C, D1, D2, or E would be of the same level as described under Alternative A—**moderate**. This impact rating is driven mostly by ongoing activities such as climate change and vessel traffic, as well as by the construction, installation, and presence of offshore wind structures.

As described above, Vineyard Wind's existing commitments to mitigation measures and BOEM's potential additional mitigation measures could further reduce impacts, but would not change the impact ratings.

3.5.4. Consequences of Alternative F

Alternative F, combined with the Proposed Action or Alternative D2 layouts, would potentially lead to a slightly increased risk of resident or migrating sea turtles encountering the WDA, or Project-related vessels, with associated impacts, as described above. Additionally, concentrating non-Project vessel traffic into a corridor may result in increased potential for vessel strikes and behavioral responses to vessel noise due to funneling of existing vessel traffic through the transit lane. When compared to Alternative A or Alternative D2, the impacts of Alternative F would be slightly increased due to the potential for longer transits to the WDA during construction, operations, and decommissioning, resulting in an increase in associated collision risk, but these impacts resulting from individual IPFs would be expected to still result in **negligible** to **moderate** impacts and potential **minor beneficial** impacts, with no measurable differences to those described under Alternative A. This is due to the total number of WTGs and associated impacts remaining the same, and the southern portion of the WDA not including areas with higher densities of sea turtles. The impacts from the combination of Alternative F with Alternative A or Alternative D2 are expected to be similar to combinations with the other alternatives. Consequently, these other potential combinations are not separately analyzed here.

BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. In context of reasonably foreseeable environmental trends, the impacts of ongoing and planned actions, including Alternative F, would not likely be materially different than those described under Alternative A (with individual IPFs leading to impacts ranging from **negligible** to **moderate** and may include **minor beneficial** impacts). The overall impacts of Alternative F would not be expected to be materially different from Alternative A—**moderate**. This impact rating is driven mostly by ongoing activities, such as climate change and vessel traffic, as well as by the construction, installation, and presence of offshore wind structures.

BOEM has qualitatively evaluated the impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease

Areas. To the extent additional transit lanes are implemented in the future outside the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located farther from shore, similarly to the proposed Project under Alternative F. If all the proposed transit lanes were implemented, this would not allow the technical capacity of offshore wind power generation assumed in Chapter 1 to be met. If in the future all six transit lanes were implemented, the overall number of WTGs would likely be less and therefore translate to less pile-driving noise and associated potential for auditory injury. Overall impacts on sea turtles from six transit lanes may result in slightly greater impacts due to funneling of ongoing non-Project-related vessel traffic, but the impacts would be expected to remain the same as a result of the patchy distribution of sea turtles in the geographic analysis area.

As described above, Vineyard Wind's existing commitments to mitigation measures and BOEM's potential additional mitigation measures could further reduce impacts, but would not change the impact ratings.

3.5.5. Comparison of Alternatives

As discussed above, the impacts and the potential beneficial impacts associated with Alternative A alone would not change substantially under Alternatives C through F. While the alternatives have some potential to result in slightly different impacts on sea turtles, the same construction, operations, maintenance, and decommissioning activities would still occur, albeit at differing scales in some cases. Alternatives D1, D2, and F may result in slightly more, but not measurably different, impacts due to an expanded Project footprint and required additional HRG surveys. Alternative E would result in slightly less impacts due to a reduced number of WTGs and Project footprint, and would result in less incidental take of sea turtles (NMFS 2020b). Furthermore, in context of reasonably foreseeable environmental trends, impacts on sea turtles would be slightly higher, but not measurably different, under Alternatives D1, D2, and F, and slightly lower, but not measurably different under Alternative E. However, the overall impact of any action alternative when combined with other planned actions would be similar because the majority of the impacts of any alternative come from other future offshore wind developments, which do not materially change between alternatives. See Table 2.4-1 for a comparison of alternative impacts.

3.5.6. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. The Preferred Alternative incorporates all the mitigation measures listed in Appendix D for this resource. Under the Preferred Alternative, the WDA would contain between 57 to 84 WTGs. This alternative would result in at least 16 fewer WTGs than Alternative A, resulting in a reduction of pile driving days, vessel traffic, duration of acoustic impacts, and impacts on water quality and the benthic environment compared to Alternative A. The Preferred Alternative would result in reduced potential impacts on sea turtles by imposing mitigation measures outlined in Appendix D, which would be applied to all Project alternatives, including the Preferred Alternative. Impacts on sea turtles would be reduced through near-term refinement of monitoring zones and clearance zones based on field measurements of noise reduction systems, and long-term refinements of other pile-driving monitoring protocols based on monthly and/or annual monitoring results. Daily pre-construction visual surveys and the sunrise and sunset prohibition on pile driving would reduce the likelihood of impacts on sea turtles. Monitoring for, and cleanup of, charter and recreational fishing gear around WTG foundations would decrease ingestion by and entanglement in gear by sea turtles. Based on the maximum radial distance to the injury threshold for sea turtles, soft-starts to allow turtles to leave the area before injurious levels are received, and the implementation of monitoring zones and clearance zones, mortal injury would not be expected. As discussed in the BO, take of 11 ESA-listed sea turtles as a result of behavioral disturbance during pile-driving activities are expected to occur during the installation of no more than 84 WTGs. The requirement of AIS on all Project vessels would allow Vineyard Wind to monitor the number of vessels and traffic patterns for compliance with vessel speed requirements and would decrease the potential for vessel strike on sea turtles. BOEM anticipates the potential impacts of vessel strike on sea turtles due to construction and installation vessels to be minor, as most impacts would be avoided with the implementation of proposed Project-specific mitigation. As discussed in the BO, take of a total of 39 ESA listed sea turtles may occur as a result of vessel strike over the life of the proposed Project. Because impacts on foraging habitat are mostly temporary and localized, BOEM anticipates the impact of the Preferred Alternative activities associated with bottom disturbance on sea turtles to be **minor**, with a complete recovery of pre-construction species assemblages without any mitigation.

Considering the mitigation measures included as part of the Preferred Alternative, BOEM anticipates that potential overall impacts on sea turtles resulting from the Preferred Alternative would be **negligible** to **moderate** and could include **minor beneficial** impacts.

3.6. DEMOGRAPHICS, EMPLOYMENT, AND ECONOMICS

3.6.1. No Action Alternative and Affected Environment

This section discusses demographic, employment, and economic conditions in the geographic analysis area described in Table A-1 in Appendix A and shown on Figure A.7-7. Specifically, this includes the counties where proposed onshore infrastructure and potential port cities are located, as well as the counties in closest proximity to the WDA: Barnstable, Bristol, Dukes, and Nantucket counties, Massachusetts; and Providence and Washington counties, Rhode Island. Data for the states of Massachusetts and Rhode Island are provided for reference. Table 3.6-1 describes baseline conditions and the impacts of ongoing and future offshore activities other than offshore wind on demographics, employment, and economics based on the IPFs assessed.

Proposed Project facilities and associated port activities would be located primarily within coastal Massachusetts and Rhode Island. Tables F.2-1 through F.2-9 in Appendix F provide detailed demographic information for the study area.

Barnstable, Dukes, and Nantucket Counties

Barnstable, Dukes, and Nantucket counties are notable for the importance of coastal tourism and recreation to their economy and their high proportion of seasonal housing.

The population of Barnstable County declined by 3.8 percent from 2000 to 2018, while the population of Dukes and Nantucket Counties grew substantially by 16 and 17 percent, respectively. Dukes and Nantucket counties have the smallest population of any counties in Massachusetts. The population of Barnstable and Dukes counties are older, on average, than the population of surrounding counties and Massachusetts as a whole, while Nantucket County's age distribution is similar to the statewide profile (U.S. Census Bureau 2012, 2020a).

Barnstable, Dukes, and Nantucket counties are notable for the importance of tourism and visitors to their economy and their high proportion of seasonal housing. In Massachusetts as a whole, 4 percent of housing units are seasonally occupied, as compared to 38 percent of homes in Barnstable County and 62 percent of homes in both Dukes County and Nantucket County (U.S. Census Bureau 2020b). Towns in Barnstable County experience significant seasonal population growth. During the peak tourist season from June through August, the population of Cape Cod grows by "an equivalent [of] 68,856 full time residents" (COP Volume III, Section 7.1.1.1.1; Epsilon 2020b), equivalent to approximately 32 percent of Barnstable County's 2018 population. In addition, "seasonal population continues to grow even as the number of Cape Cod's year-round residents decreased" (COP Volume III, Section 7.1.1.1.1; Epsilon 2020b). Unemployment rates in the three-county area are lower than in Massachusetts as a whole. In 2018, unemployment was 2.8 percent in Nantucket County, 4.7 percent in Barnstable County, and 3.2 percent in Dukes County, as opposed to 5.4 percent in Massachusetts (U.S. Census Bureau 2020a).

The industries that employ workers ("at place" employment—Table F.2-5 in Appendix F) reflect the importance of tourism to these counties. A greater proportion of jobs are in entertainment, recreation, accommodation, and food service (18 to 21 percent) than in Massachusetts as a whole (11 percent). In addition, 18 to 19 percent of jobs in Barnstable, Dukes, and Nantucket Counties are in retail trade, as compared to 11 percent statewide. A higher proportion of jobs in the three counties are also in construction—8, 13 and 18 percent, in Barnstable, Dukes, and Nantucket counties, respectively, as opposed to 4 percent statewide (U.S. Census Bureau 2020a).

The NOAA tracks economic activity dependent upon the ocean in its "Ocean Economy" data, which generally include commercial fishing and seafood processing, marine construction, commercial shipping and cargo handling facilities, ship and boat building, marine minerals, harbor and port authorities, passenger transportation, boat dealers, and coastal tourism and recreation, among others. Table F.2-8 in Appendix F reports data on the Ocean Economy as a whole in terms of gross domestic product (GDP) and employment; Table F.2-9 in Appendix F reports employment by sector. In Barnstable, Dukes, and Nantucket counties, tourism and recreation accounted for 87, 93, and 98 percent of the overall Ocean Economy GDP (NOAA 2020l). This category includes recreational and charter fishing, as well as commercial ferry services based in Hyannis Harbor and Woods Hole, which provide service to Nantucket, Martha's Vineyard, and other locations. The Woods Hole, Martha's Vineyard, and Nantucket Steamship Authority generated nearly $104 million in revenues in 2016 with almost 2,466,800 passenger trips, while Hy-Line Cruises' ferry service between Hyannis, Martha's Vineyard, and Nantucket had approximately 713,400 passenger trips (Steamship Authority 2018).

The "living resource" sector of the Ocean Economy includes commercial fishing, aquaculture, seafood processing, and seafood markets. Although the number employed or self-employed in this sector in Barnstable, Dukes, and Nantucket counties is small compared to recreation and tourism (Table F.2-9 in Appendix F), local fishing fleets form an important part of the identity and tourist attraction of local communities. As an example, the Town of Chilmark on Martha's Vineyard was host to a commercial fishing fleet of 17 vessels in 2014, of which 16 were classified as small vessels (less than 50 feet [15.2 meters]) (NEFSC 2014). The fleet is important to the identity of the Village of Menemsha in Chilmark, a harbor village that also has local seafood markets, processing businesses, charter fishing companies, restaurants, and tourist-oriented retail stores. Local efforts are underway to support the small-scale commercial fishing fleets. In Martha's Vineyard, the fishing industry has formed the Martha's Vineyard Fishermen's Preservation Trust, a nonprofit organization that raises funds to purchase fishing permits and lease their affiliated quota, or the right to catch a certain amount of fish or shellfish, to local small-scale fishermen, in an effort to ensure a viable commercial fishing community (MV Fishermen's Preservation Fund 2017).

Menemsha is one example of fishing communities with established cultural identities and place attachments strongly correlated with the fishing economy. Place attachments can be defined as connections to physical and social settings that provide social and psychological benefits. Factors related to place attachments can impact well-being of individuals and the community as a whole (Khakzad and Griffith 2016). NMFS's Social Indicator Map (NMFS 2019) classifies fishing communities in Barnstable, Dukes, and Nantucket counties as having varying levels of social vulnerability, in part based on commercial fishing engagement and reliance. The community of Chatham was rated high on commercial fishing engagement and reliance. The communities of Barnstable Town and Sandwich were rated medium-high for commercial fishing engagement and medium for commercial fishing reliance. Other communities in Barnstable, Dukes, and Nantucket counties were rated medium to low in both categories.

Bristol County, Massachusetts

Bristol County is a manufacturing center and has an ocean-based economy dominated by shipping, seafood processing and commercial fishing. New Bedford in Bristol County is a nationally important commercial fishing center.

Bristol County is more densely populated than Massachusetts as a whole and had lower per capita income and housing values. As shown in Appendix F, manufacturing and wholesale trade jobs account for more than 19 percent of the county's at-place employment, compared to 11 percent statewide (U.S. Census Bureau 2020a). In 2017, Ocean Economy activities accounted for 3 percent of Bristol County's GDP, and employed approximately 9,105 individuals, including self-employed individuals (Table F.2-8 in Appendix F). Commercial fishing, aquaculture, and seafood processing accounted for 65 percent of Bristol County's total Ocean Economy value (NOAA 2020l) and 26 percent of the Ocean Economy employment (Table F.2-9 in Appendix F). The unemployment rate in Bristol County was 5.8 percent in 2018, similar to the statewide rate (U.S. Census 2020a).

The Port of New Bedford, a full-service port with well-established fishing and cargo handling industries, is an international seafood hub and the highest-grossing commercial fishing port in the United States (Sasaki et al. 2016; New Bedford Port Authority 2018). The Port of New Bedford generated 14,429 jobs in 2018 (direct, indirect, and induced),[12] mostly from commercial fishing and seafood processing activity (Martin Associates 2019). The seafood processing industry at New Bedford handles seafood landed at New Bedford Harbor as well as seafood from other domestic and international sources. A total of 571 jobs were generated directly by non-seafood cargo and recreational boating activity (ferries, water taxis, and marinas). An additional 26,499 related jobs were generated by

[12] The terms "direct," "indirect," and "induced" are commonly used both within and outside the NEPA context to describe economic impacts and are thus used in this section. The remainder of the FEIS does not distinguish between direct and indirect impacts.

downstream logistics operations in seafood processing, after the seafood leaves the port processing operations and cold storage facilities (Martin Associates 2019).

Vineyard Wind has signed a lease to use the MCT at the Port of New Bedford, a facility developed by the port specifically to support the construction of offshore wind facilities, to support proposed Project construction. The port would also likely support maintenance and operations activities given its infrastructure to stage offshore wind components.

Depending on demands and activities at the MCT, the proposed Project may conduct staging activities in other areas at the Port of New Bedford, at the ports of Montaup or Brayton Point, both in Bristol County, or at other ports in Rhode Island (see below). The Montaup and Brayton Point ports are both at the site of decommissioned power plants. The recent history of industrial activity in these locations suggests the presence of a skilled workforce consistent with proposed Project needs.

NMFS classifies fishing communities in New Bedford and Fairhaven as having high commercial fishing engagement and medium (Fairhaven) to low (New Bedford) reliance. Westport and Fall River were classified as having medium-high commercial fishing engagement, and low (Westport) and medium (Fall River) commercial fishing reliance. Other communities in Bristol County are identified as having medium to low ratings in both categories (NMFS 2019).

Providence and Washington Counties, Rhode Island

Providence and Washington counties have diverse economies. Their ocean-based economy sectors include shipping and commercial fishing in addition to tourism-related economic activity. Point Judith in Washington County is a center for the regional commercial and recreational for-hire fishing industries.

The City of Providence is the state capital and largest city in Rhode Island, and has approximately 60 percent of the state's population. As shown in Appendix F, housing values and per capita income are lower than the state average, while unemployment is higher than the state average (U.S. Census Bureau 2020b).

The Port of Providence (ProvPort) is a privately owned marine terminal that has generated approximately $164 million in economic output for Providence and $211 million for the State of Rhode Island since 1994 (COP Volume III, Section 7.1.1.2.1; Epsilon 2020b). In 2017, Ocean Economy activities accounted for 2 percent of Providence County's GDP (Table F.2-7 in Appendix F), about 87 percent of which was associated with tourism and recreation (NOAA 2020l).

Washington County contains only 12 percent of the state's population. Median per capita income and housing values are higher than the statewide figures, while unemployment rates and home vacancy rates are lower. A higher proportion of homes are seasonally occupied (17 percent) than in the state as a whole (4 percent) (U.S. Census Bureau 2020b). In 2017, Ocean Economy activities accounted for 18 percent of the Washington County's total GDP (Table F.2-7 in Appendix F). Washington County has a diverse Ocean Economy; tourism and recreation accounted for 29 percent of the county's total Ocean Economy value and 54 percent of Ocean Economy employment, while the "living resources" sector accounted for 6 percent of the Ocean Economy value and 7 percent of employment (Table F.2-8 in Appendix F) (NOAA 2020l and m).

The Port of Davisville in Washington County, known locally as Quonset Point, is an industrial center in addition to a port, and home to more than 200 companies and nearly 11,000 workers (COP Volume III, Section 7.1.1.2.2; Epsilon 2020b). Washington County also contains Point Judith, a center of the Rhode Island fishing industry.

Statewide, Rhode Island has a diverse Ocean Economy. The primary sectors in the total Ocean Economy value of $2.6 billion in 2017 were tourism and recreation (60.7 percent), ship building (22.1 percent), marine transportation (11.5 percent), and living resources (3.4 percent). A 2018 study estimated that the commercial seafood industry statewide generated 3,147 jobs and $538 million in sales in 2016 (Sproul and Michaud 2018), with commercial fishing providing the highest number of firms and employees (Table 3.6-2).

NMFS classifies fishing communities in Providence County as having low commercial fishing engagement and reliance. The communities of North Kingstown and Narragansett/Point Judith were identified as having high commercial fishing engagement and low (North Kingstown) to medium (Narragansett/Point Judith) reliance. The community of South Kingston was identified as having medium-high commercial fishing engagement, and low reliance. Other communities in Providence and Washington counties are identified as having medium to low ratings in both categories (NMFS 2019).

Trends under the No Action Alternative

Over the Project's proposed lifetime, BOEM does not anticipate major changes to the distribution of economic sectors in the study area. Dukes, Barnstable, and Nantucket counties would continue to rely economically on coastal tourism and recreation. In Bristol, Providence and Washington counties, the Ocean Economy sector would continue to be more diverse, with a higher proportion of shipping and commercial fishing, while also constituting a smaller proportion of these counties' total economy. The analysis area may experience substantial increased economic activity associated with offshore wind activities, as discussed in the next section.

3.6.1.1. Future Offshore Wind Activities (without Proposed Action)

Offshore wind could become a new industry for the Atlantic states and the nation. Several recent reports provide national estimates of employment and economic activity. These studies acknowledge that offshore wind component manufacture and installation capacity exists primarily outside the United States; however, domestic capacity is anticipated to increase. This FEIS uses available data, analysis, and projections to make reasoned conclusions on potential economic and employment impacts within the geographic analysis area. The FEIS provides no analysis or conclusions about impacts outside the geographic analysis area (i.e., regional, national, or worldwide).

The BVG (2017) study estimated that during the initial implementation of offshore wind projects along the U.S. northeast coast, a base level of 35 percent of jobs, with a high probability of up to 55 percent of jobs, would be sourced from within the United States. The proportion of jobs filled within the United States would increase as the offshore wind energy industry grows, due to growth of a supply chain and supporting industries along the east coast, as well as a growing number of local operations and maintenance jobs for established wind facilities. By 2030 and continuing through 2056, approximately 65 to 75 percent of jobs associated with offshore wind are projected to be within the United States. Overseas manufacturers of components and specialized ships based overseas that are contracted for installation of foundations and WTGs would fill jobs outside of the United States (BVG 2017). As an example of the mix of local, national, and foreign job creation, for the 5-turbine Block Island Wind Farm, turbine blade manufacturing occurred in Denmark, generator and nacelle manufacturing occurred in France, tower component manufacturing occurred in Spain, and foundation manufacturing occurred in Louisiana (Gould and Cresswell 2017).

The American Wind Energy Association (AWEA) estimates that the offshore wind industry will invest $80 to $106 billion in U.S. offshore wind development by 2030, including $28 to $57 billion invested within the United States, depending on installation levels and supply chain growth (other investment would occur in countries manufacturing or assembling wind energy components for U.S. based projects) (AWEA 2020). Economic and employment impacts would occur nationwide, but be most concentrated in Atlantic coastal states that host offshore wind development. The AWEA report lists over $1.3 billion in announced domestic investments in wind energy manufacturing facilities, ports, and vessel construction in Atlantic states (AWEA 2020). The AWEA report analyzes a base scenario and a high scenario for offshore wind direct impacts, turbine and supply chain impacts, and induced impacts. The base scenario assumes 20 GW of offshore wind power by 2030 and domestic content increasing to 30 percent in 2025 and 50 percent in 2030. The high scenario assumes 30 GW of offshore wind power by 2030 and domestic content increasing to 40 percent in 2025 and 60 percent in 2030. Under the base scenario, offshore wind energy development would support $14.2 billion in economic output and $7 billion in value added by 2030. Under the high scenario, offshore wind energy development would support $25.4 billion in economic output and $12.5 billion in value added by 2030. The AWEA analysis does not specify where supply chain growth would occur in the U.S.

The AWEA estimates are consistent with the University of Delaware (2019) projections, which estimate deployment of 18.6 GW of planned and contracted offshore wind energy projects through 2030 would require capital expenditures of $68.2 billion over the next 10 years (University of Delaware 2019). The study notes that, while the offshore wind supply chain is global and the expenditures would be directed to both domestic and foreign sources, a growing number of U.S. suppliers are preparing to enter the industry.

Compared to the $14.2 to $25.4 billion in offshore wind economic output (AWEA 2020), the 2019 annual GDP for states with offshore wind projects (Connecticut, Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina) ranged from $63.5 billion in Rhode Island to $1.73 trillion in New York (U.S. BEA 2020), and totaled nearly $5.0 trillion. The $14.2 to $25.4 billion in offshore wind industry output would represent 0.3 to 0.5 percent of the combined GDP of these states.

The AWEA study estimates offshore wind would support 45,500 (base scenario) to 82,500 (high scenario) jobs—full-time equivalent (FTE) jobs at a given point in time—in the year 2030 nationwide, including direct, supply chain, and induced jobs. Most offshore wind jobs are created during the temporary construction phase. About 60 percent of jobs would be short-term (development and construction) and 40 percent would be long-term (operations and maintenance). A 2020 study commissioned by RODA estimated that offshore wind projects through 2030 would generate 55,989 to 86,138 job-years (a FTE job lasting 1 year) for construction and 5,003 to 6,994 long-term jobs for operations and maintenance (Georgetown Economic Services 2020). These estimates are generally consistent with the AWEA study in total jobs supported, although the Georgetown Economic Services study concludes that a greater proportion of jobs would be in the construction phase. As with the AWEA estimates of economic output, the RODA study assumed that offshore wind energy jobs would be focused in states hosting offshore wind projects, but would also be generated in other states where manufacturing and other supply chain activities occur.

In 2018, employment in Rhode Island and Massachusetts combined was 4.1 million (Table F.2-2 in Appendix F). Because projected offshore wind jobs could be located anywhere in the United States, the extent of impacts on the geographic analysis area cannot be clearly foreseen; however, a substantial portion of the workforce for planned Massachusetts and Rhode Island offshore wind projects would likely be drawn from, or would relocate to, areas within commuting distance of the Port of New Bedford, ProvPort, Montaup, Brayton Point, Davisville and Vineyard Haven, and other ports that would be used for offshore wind staging, construction and operations.

Some local economic activity has already begun in preparation for the anticipated offshore wind industry. For example: Bristol Community College has initiated a training program for the offshore wind workforce; the old power plant at Brayton Point has been demolished and new port infrastructure has been installed; and improvements specifically for offshore wind are planned at ProvPort and the Port of Davisville (Brayton Point Commerce Center 2020; Offshore Source 2020; King 2019).

In addition to the regional economic impact of a growing offshore wind industry, BOEM expects future offshore wind development to affect demographics, employment, and economics through the following IPFs.

Energy generation/security: Once built, over the long term, future offshore wind could produce energy at long-term fixed costs, which could provide a hedge against fossil fuel price volatility, including volatility caused by the recent and planned retirement of nuclear, coal, and oil plants throughout New England (COP Volume III, Section 4.1.1; Epsilon 2020b; ISO New England 2020). Offshore wind could significantly increase the proportion of energy from renewable sources not subject to fossil fuel costs, with a potential for 9,404 MW of power (32.1 trillion British thermal units [Btu], compared to 72.4 trillion Btu currently provided by renewable sources in Massachusetts) from offshore wind development for Massachusetts and Rhode Island (U.S. Energy Information Administration 2018). A greater share of electricity produced by offshore wind for a given market would also result in a greater need for energy storage and peaker generation capacity, due to anticipated variations in generation. The economic impacts of future offshore wind activities (including associated energy storage and peaker generation capacity projects) on energy generation and energy security cannot be quantified, but could be long-term, and beneficial.

Light: The aviation warning lighting required for offshore WTGs would be visible from some beaches and coastlines, and could have effects on economic activity in certain locations if the lighting influences visitors in selecting coastal locations to visit, or potential residents in selecting residences. At night, required aviation obstruction lighting on the WTGs would consist of red lights on the nacelle flashing 30 times per minute, as well as mid-tower red lights flashing at the same frequency. A visual impact study provided for the proposed Project states that at distances greater than 14 miles (22.5 kilometers), aviation obstruction lights would be very low on the horizon and would vary in intensity due to the slow flash rate, intermittent shadowing as rotating blades pass in front of the light source, and atmospheric variations. Visibility would be reduced or blocked by fog, snow, or particulate matter (Vineyard Wind 2020c). Warning lighting from up to 709 WTGs (out of the 775 assumed as part of the No Action Alternative) could theoretically be visible within the geographic analysis area, depending on viewer location, vegetation, topography, and atmospheric conditions. No readily available studies characterize the impacts of nighttime offshore lighting on economic activity. Studies cited in Section 3.9 suggest that WTGs visible from more than 15 miles (24.1 kilometers) away would have negligible effects on businesses dependent on recreation and tourism activity. Up to 34 (out of the 775 assumed as part of the No Action Alternative) of the WTGs envisioned in the RI and MA Lease Areas, less than 5 percent of the total, would be less than 15 miles (24.1 kilometers) from viewers. As a result, although lighting on WTGs would have a continuous, long-term impact on demographics, employment, and economics, the impact would be limited due to the distant and variable views of nighttime lighting from coastal businesses.

ADLSs are an emerging technology that, if implemented, would only activate aviation warning lighting on WTGs when aircraft enter a predefined airspace. For the Proposed Action, this was estimated to occur 235 times during the year, with a total of 3 hours and 49 minutes (COP Volume III, Appendix III-N; Epsilon 2020b). Depending on exact location and layout, ADLS would likely result in similar limits on the frequency of WTG aviation warning lighting use on offshore wind facilities. Implementation of ADLS could thus reduce the amount of time that WTG lighting is visible, thereby making WTG lighting visible only sporadically, rather than continuously at night. This would reduce the impacts on demographics, employment, and economics associated with lighting.

Nighttime construction and maintenance of offshore wind projects would require lighting for vessels in transit and at offshore construction work areas. Concurrent construction of up to four offshore wind projects (not including the Proposed Action) could occur in 2024, all potentially contributing to nighttime vessel lights. Vessel lighting would enable commercial shipping and commercial fishing operations to safely navigate around the vessels and work areas and would be visible from coastal locations, primarily while the vessels are in transit. Vessel lighting is not anticipated to impact the volume of business at visitor-oriented businesses or other businesses. Impacts of vessel lighting would be localized, short-term, intermittent, and possibly adverse.

New cable emplacement and maintenance: Offshore cable emplacement for future offshore wind would temporarily impact commercial/for-hire fishing businesses based in the geographic analysis area during cable installation and infrequent maintenance. Cable emplacement for offshore wind would occur offshore from the geographic analysis area for demographics, employment, and economics, resulting in about 3,398 acres (13.8 km^2) of seafloor disturbance (based on the assumptions in Appendix A), and fishing vessels may not have access to impacted areas during active construction. The disruption from cable installation may occur concurrently or sequentially, with similar impacts on commercial fishery resources. Disruption may result in conflict over other fishing grounds, increased operating costs for vessels, and lower revenue (e.g., if the substituted fishing area is less productive or supports less valuable species). Short-term productivity reductions would also affect seafood processing and wholesaling businesses that depend upon the fishing industry.

Assuming projects use installation procedures similar to those proposed in the Vineyard Wind COP (COP Volume I, Section 3; Epsilon 2020a), the duration and extent of impacts would be limited. Commercial and for-hire fishing and the related processing industries represent a small portion of the employment and economic activity in the geographic analysis area. The economic impact of cable emplacement and maintenance on commercial/for-hire fishing businesses is covered in more detail in Section 3.10 and would be localized and short-term.

Noise: Noise from site assessment G&G survey activities, operations and maintenance, pile driving, trenching, and vessels could result in temporary, impacts on employment and economics via the impacts on marine businesses (e.g., commercial fishing, for-hire recreational fishing, and recreational sightseeing).

Noise (especially site assessment G&G surveys and pile driving) would affect fish populations, with effects on commercial and for-hire fishing. As discussed in Sections 3.3 and 3.10, increased noise could temporarily affect the availability of fish within work areas, causing fishing vessels to relocate to other fishing locations in order to continue to earn revenue. This could potentially lead to increased conflict in relocation areas, increased operating costs for vessels, and lower revenue. The severity of such impacts would depend on the overlap of construction activities, where construction activities occur in relation to preferred fishing locations, and how exactly the commercial fishing industry responds to future construction activities.

Population-level impacts on marine mammals would have impacts on employment and economic activity as a result of the impact on marine sightseeing businesses that benefit from the visible presence of marine mammals in the waters offshore from the geographic analysis area. As stated in Section 3.4, noise impacts associated with future offshore wind development could contribute to impacts on individual marine mammals. If multiple project construction activities occur in close spatial and temporal proximity, population-level impacts are possible; however, as noted in Section 3.4, BMPs can minimize exposure of individual mammals to harmful impacts and avoid population-level effects.

As noted in Section 3.3, noise from trenching and vessel operation is expected to occur, but would have little effect on finfish, invertebrates, and EFH, and therefore little effect on commercial or for-hire fishing or recreational businesses. Likewise, offshore wind projects may use aircraft for crew transport during maintenance and/or construction; however, aircraft noise is not likely to affect finfish, invertebrates, EFH, or marine mammals. 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 affect finfish, invertebrates, and EFH (English et al. 2017).

Offshore wind-related construction noise from pile driving, cable laying and trenching, and vessels are anticipated to have an impact on tour boat and for-hire fishing businesses, making the affected areas temporarily unattractive for the visitor-oriented businesses. Impacts would be localized and temporary.

Overall, offshore wind-generated noise could result in visitor-oriented services avoiding areas of noise, and impacts on marine life important for fishing and sightseeing. Section 3.10 provides detail on potential economic impacts on commercial/for-hire fishing businesses. Both types of impacts would be localized and short-term, 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 in the marine area off the coast of the geographic analysis area. As indicated in Appendix A, Table A-4, the RI and MA Lease Areas could have 775 offshore WTGs and 20 ESPs installed within a 6- to 10-year period, with Project construction beginning in 2022 and continuing through 2030.

Onshore construction noise would temporarily inconvenience visitors, workers, and residents, possibly resulting in a short-term reduction of economic activity for businesses near installation sites for onshore cables, substations, or port improvements. Because the location of onshore improvements is not known and cannot be determined until specific projects are proposed, the magnitude of noise associated with onshore construction and the number of businesses and homes affected cannot be determined. Impacts on demographics, employment, and economics from noise would be, intermittent and short-term, similar to other onshore utility construction activity.

Port utilization: Future offshore wind development would support use and expansion of ports and supporting industries in Rhode Island and Massachusetts, including several ports indicated as possibly supporting proposed Project construction: the ports of New Bedford, Montaup, and Brayton Point in Bristol County, ProvPort in Providence County, and the Port of Davisville (Quonset Point) in Washington County (Appendix A, Section A.5). The Massachusetts Clean Energy Center (MassCEC) identified 18 waterfront sites in Massachusetts that may be available and suitable for use by the offshore wind industry (MassCEC 2017a), including the Brayton Point and Montaup Power Plant sites (MassCEC 2017a and b), which are retired power plant sites with a long history of industrial (power production) use. Brayton Point is currently being redeveloped into a port and support center for offshore wind (Brayton Point Commerce Center 2020). Deepwater Wind has committed to improvements to Rhode Island ports in the geographic analysis area (ProvPort and the Port of Davisville) in support of the Revolution Wind Project (Kuffner 2018).

Although beyond the scope of this analysis, ports outside the geographic analysis area would also benefit from the economic activity generated by offshore wind. The sites that the MassCEC identified would potentially support staging, assembly, and deployment of turbine components; construction and staging of foundations; manufacturing of components; and long-term operations and maintenance facilities. Five sites are in the Somerset/Fall River area and six are in the New Bedford port area, all within Bristol County (in the geographic analysis area). The remaining seven sites are in the greater Boston area. The national projections of employment and economic activity resulting from Atlantic OCS wind installation would have been generated based in part on additional planned investments, including other east coast ports outside the geographic analysis area. These general projections, cited at the beginning of Section 3.6.1.1, are used to draw reasonable conclusions about anticipated economic impact within the geographic analysis area.

Port utilization would require additional shore-based and marine workers, resulting in a trained workforce for the offshore wind industry and contributing to beneficial local and regional economic activity. Where existing ports are improved and channels are dredged for use in support of offshore wind, the improvements would also be beneficial to other port activity. Port utilization in the geographic analysis area associated with offshore wind would occur primarily during development and construction of projects offshore of Massachusetts and Rhode Island, which are anticipated to occur primarily between 2022 and 2030 (Appendix A, Table A-6). Ongoing maintenance and operational support would sustain port activity and employment at a lower level once construction is complete.

The port investment and usage generated by offshore wind would have long-term, beneficial impacts on employment and economic activity by providing employment opportunities and supporting marine service industries such as marine construction, ship construction and servicing, and related manufacturing. The most intensive beneficial impacts would occur during construction of offshore wind projects near the geographic analysis area between 2022 and 2030. The beneficial impact of offshore wind operations and maintenance services and improved port facilities would provide sustained long-term employment and economic activity.

Port usage could potentially have short- to medium-term adverse impacts on commercial shipping if offshore wind construction results in competition for limited berthing space and port services. The proposed Brayton Point and Montaup sites are redevelopment sites specifically for offshore wind, and would thus accommodate offshore wind activity without competing with other marine interests. The MCT at the Port of New Bedford was built specifically to support offshore wind, and the ports of Davisville and ProvPort are pursuing expansion suitable for offshore wind development support. Depending on the success of these planned expansions and the volume of activity at these and other ports outside the geographic analysis area, offshore wind development could result in increased competition and costs as well as possible delays or displacement for current port users.

Presence of structures: The structures required for future offshore wind, including the 775 WTGs, 20 ESPs, and offshore cables and foundations protected with up to 1,029 acres (4.2 km^2) of hard cover, could affect marine-based businesses. Commercial fishing operators, marine recreational businesses, and shore-based supporting services (such as seafood processing) could experience both short-term impacts during construction as well as long-term impacts from the presence of structures.

Commercial and for-hire recreational fishing businesses could experience impacts due to higher costs and reduced income during construction, operations and maintenance, and decommissioning, resulting from the need to adjust routes and fishing grounds to avoid offshore construction areas, as well as operational WTGs and ESPs during operations. Allisions could lead to vessel damage and spills, with direct costs (i.e., vessel repairs and spill cleanup) as well as indirect costs from damage caused by spills. Section 3.10 also discusses economic impacts on commercial or for-hire recreational fishing. In addition to the impact from the need to avoid structures and the complexities of navigating through the developed offshore wind projects, the scour protection and foundations of offshore wind structures could provide new opportunity for for-hire recreational fishing businesses and certain types of commercial fishing by attracting certain fish through the reef effect (Section 3.10).

Commercial fishing businesses would also be affected by the use of concrete mattresses to cover cables in hard-bottom areas during offshore wind operation. Commercial trawlers/dredgers would need to be aware of and avoid the locations of concrete cable coverage to avoid potential gear loss, damage, or entanglement. The impacts of concrete cable protection on commercial fishing businesses would be long-term and localized. Operators would be able to adjust to avoid affected locations, but the complexity of selecting fishing areas, and the areas where trawling or dredging methods cannot be used without possible gear loss would increase as the extent of hard coverage area increases.

Offshore wind structures could also hinder the current routes of commercial vessels providing offshore recreational services, although many such businesses would be able to adjust by changing routes with limited effects. The presence of WTGs could require adjustment of vessel routes used for activities such as sailboat races, tour boat routes, and recreational fishing.

Long-distance sailing races that traverse the waters offshore of the geographic analysis area, such as the Transatlantic Race, Marion to Bermuda Race, and Newport Bermuda Race, generate business for visitor services within the geographic analysis area. These races may vary in their routes and only occur every 2 to 4 years, so impacts of offshore wind construction areas and permanent structures would depend upon the particular locations where construction would occur or be completed at the time of a specific race. With advance communication and planning, races could be routed to avoid offshore wind construction areas or structures.

Recreational fishing targeting HMS such as tuna, shark, and marlin also generates business for charter fishing businesses and visitor services. These businesses are likely to be affected by offshore wind structures because the HMS fisheries are more likely to overlap areas where offshore wind development would occur than other fisheries, which tend to occur closer to shore. While HMS angling has fewer participants and trips than coastal recreational fishing, HMS anglers often spend significantly more than other fishing participants on individual fishing trips and tournaments. There were 20,020 vessels with a permit for Atlantic HMS in 2016 (NOAA 2019c).

The fish aggregation and reef effects of up to 413 acres (1.7 km^2) of hard coverage around offshore wind structures would also provide new opportunities for recreational fishing. Aggregation and reef effects would impact the minority of recreational fishing vessels that travel as far from shore as offshore wind structures (Section 3.9). Although the likelihood of recreational vessels visiting offshore foundations would vary based on relative proximity to shore, increasing offshore wind development could change recreational fishing patterns within the larger socioeconomic study area, as the tourist industry learns to make use of the structures. Businesses that would benefit from fish aggregation and reef effects—such as those that cater to HMS and offshore fishing recreationists—may grow. The attraction of anglers to offshore wind structures is not anticipated to result in a volume of new recreational fishing large enough to replace or displace commercial fishing businesses by recreational fishing businesses.

In summary, offshore wind structures and hard coverage for cables would have long-term impacts on commercial fishing operations and support businesses such as seafood processing. The impacts would increase in intensity as more offshore structures are completed, but the fishing industry is anticipated to be able to adjust fishing practices over time in order to maintain the commercial fishing industry in the context of offshore wind structures. (Also see discussion of economic impacts on commercial and for-hire recreational fishing in Section 3.10.) The offshore structures would also necessitate alterations in the routes of for-hire recreational fishing, recreational tour boat businesses, sailing races, and HMS angling. Some offshore wind structures would provide new business opportunities due to fish aggregation and reef effects—which could attract fish valued for recreational fishing—and the possibility of tours for visitors interested in a close-up view of the wind structures, as has occurred for the Block Island Wind Farm.

The views of offshore WTGs could have impacts on certain businesses serving the recreation and tourism industry. Impacts could be adverse for particular locations if visitors and customers avoid certain businesses (i.e., hotels or rental dwellings) due to views of the WTGs; impacts could be neutral or beneficial if views do not affect visitor decisions or influence some visitors beneficially. As discussed in Section 3.9, portions of up to 775 WTGs would theoretically be visible from beaches and coastal areas in the geographic analysis area for demographics, employment, and economics.

A joint research study of the University of Connecticut and Lawrence Berkeley National Laboratory found no net effects from WTGs on property values in Massachusetts (Atkinson-Palombo and Hoen 2014). The study examined impacts of 41 onshore WTGs located 0.25 to 1 mile (0.4 to 1.6 kilometers) from residences. The study noted weak evidence linking the announcement of new WTGs to adverse impact on home prices, and found that those effects were no longer apparent after the start of WTG operations. The offshore wind structures would be different from the report data in that offshore WTGs would be much larger than the onshore WTGs, but located much further from residences and appear small on the horizon. (See also Section 3.9 for additional discussion of visual impact and effect on vacation rental properties.)

Overall, the presence of offshore wind structures would have a continuous, long-term impact on employment and economics in commercial/for-hire fishing, marine recreation and coastal recreation and tourism.

Vessel traffic and vessel collisions: Offshore wind construction and decommissioning and, to a lesser extent, offshore wind operations would generate increased vessel traffic. This additional traffic would support increased employment and economic activity for marine transportation and supporting businesses, investment in the ports of New Bedford, Montaup, Brayton Point, ProvPort, and Davisville (Quonset Point), and investment in other ports outside of the geographic analysis area. Increased vessel traffic would have continuous, beneficial impacts during all project phases, with stronger impacts during construction and decommissioning.

Impacts of short-term increased vessel traffic during construction could include increased vessel traffic congestion, delays at ports, and a risk for collisions between vessels. As stated in Section 3.11, future offshore wind projects would result in a small incremental increase in vessel traffic, with a short-term peak during construction. Increased vessel traffic would be localized near affected ports and offshore construction areas. Congestion and delays could increase fuel costs (i.e., for vessels forced to wait for port traffic to pass), and could decrease productivity for commercial shipping, fishing, and recreational vessel businesses, whose income depends on the ability to spend time out of port. Collisions could lead to vessel damage and spills, which could have direct costs (i.e., vessel repairs and spill cleanup) as well as indirect costs from damage caused by spills.

The magnitude of increased vessel traffic is described in more detail in Section 3.11, and would depend upon the vessel traffic volumes generated by each offshore wind project, the extent of concurrent or sequential construction of wind energy projects, and the ports selected for each project. Increased vessel traffic congestion and collision risk would have continuous, short-term impacts during all project phases, with stronger impacts during construction and decommissioning.

Land disturbance: Offshore wind development would require onshore cable installation, substation construction or expansion, and possibly expansion of shore-based port facilities. Depending on siting, land disturbance could result in localized, temporary disturbances of businesses near cable routes and construction sites for substations and other electrical infrastructure, due to typical construction impacts such as increased noise, traffic, and road disturbances. These impacts would be similar in character and duration to other common construction projects, such as utility installations, road repairs, and industrial site construction. Impacts on employment would be localized, temporary, and both beneficial (jobs and revenues to local businesses that participate in onshore construction) and adverse (lost revenue due to construction disturbances).

Climate change: Climate change could have impacts on demographics, employment, and economics. Property or infrastructure damage, resulting from sea level rise and increased storm severity/frequency, could lead to increased insurance costs and reduced economic viability of coastal communities. Efforts to construct protective barriers and sea walls would generate employment, but would require substantial public funding requiring either new taxes or diversion of existing tax revenue from current uses. Erosion and deposition of sediments could damage structures, infrastructures, beaches, and coastal land, with numerous economic impacts. Ocean acidification, altered habitats, altered migration patterns, and increased disease frequency in marine species would have potential impacts on commercial and for-hire fishing, individual recreational fishing, and sightseeing.

Because the future offshore wind facilities would produce less GHG emissions than fossil-fuel-powered generating facilities with similar capacities, the reduction in GHG emissions due to future offshore wind projects (or avoidance of increased GHG emissions from equivalent fossil-fuel-powered energy production) would result in long-term beneficial impacts on demographics, employment, and economics. Section A.8.1 describes the expected contribution of offshore wind to climate change.

3.6.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, the geographic analysis area would continue to be influenced by regional demographic and economic trends.

While the proposed Project would not be built under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind activities, and future offshore wind activities to continue to sustain and support growth of the geographic analysis area’s diverse economy, based on anticipated population growth and ongoing development of businesses and industry. Tourism and recreation would continue to be important to the economies of the coastal areas, especially Barnstable, Nantucket, and Dukes counties. Marine industries such as commercial fishing and shipping would continue to be active and important components of the regional economy. Counties in the geographic analysis area would continue to seek to diversify their economies, protect environmental resources, and maintain or increase their year-round population.

BOEM anticipates that ongoing activities related to the IPFs (continued commercial shipping and commercial fishing; ongoing port maintenance and upgrades; periodic channel dredging; maintenance of piers, pilings, seawalls, and buoys; and the use of small-scale, onshore renewable energy) will have **minor** impacts and **minor beneficial** impacts on demographics, employment, and economics. Planned activities for coastal and marine activity, other than offshore wind, include development of diversified, small-scale, onshore renewable energy sources and peaker plants; ongoing onshore development at or near current rates; continued increases in the size of commercial vessels; potential port expansion and channel deepening activities; and efforts to protect against potential increased storm damage and sea level rise. BOEM anticipates that the demographic, employment, and economic impacts of these planned activities, other than offshore wind, will be **minor** adverse impacts and **minor** beneficial impacts. BOEM expects the combination of ongoing and planned activities, other than offshore wind, to result in **minor** adverse impacts **and minor beneficial** impacts on ocean-based employment and economics, driven primarily by the continued operation of existing marine industries, especially commercial fishing, recreation/tourism, and shipping; increased pressure for environmental protection of coastal resources; the need for port maintenance and upgrades; and the risks of storm damage and sea level rise.

Regional offshore wind development as described in Section 3.6.1.1 is anticipated to generate increased investment within the geographic analysis area in ports, shipping and logistics capability (both land and marine), component laydown and assembly facilities, job training, and other services and infrastructure necessary for offshore wind construction and operations. If U.S. supply chains develop as anticipated, additional manufacturing and servicing businesses would result, either in the analysis area, or at other locations in the United States. While it is not possible to estimate the extent of job growth and economic output within the analysis area specifically, the projections described in Section 3.67.1.1 for jobs and investment would result in notable and measurable benefits to employment, economic output, infrastructure improvements, and community services, especially job training, that occur as a result of offshore wind development. If the proposed Project is not built, the specific commitments included in Vineyard Wind's Host Community Agreement (HCA) with the Town of Barnstable (2018b), as well as its Community Benefit Agreement with Vineyard Power (Vineyard Power Undated) (Section 3.6.2) would not be realized; however, BOEM anticipates that other offshore wind projects in the RI and MA Lease Areas would enact similar commitments in the geographic analysis area.

BOEM recognizes that many jobs generated by offshore wind are temporary construction jobs, lasting for a year or less. The finding of a notable long-term benefit is supported by the medium-term (10 to 20 years) job market for offshore wind construction; the long-term operations and maintenance jobs (25 to 30 years); long-term tax revenues; the long-term economic benefits of improved ports and associated industrial land areas; diversification of marine industries, especially in areas currently dominated by recreation and tourism; and growth in a skilled marine construction workforce. Accordingly, based on the impact definitions in Table 3-2 in Section 3.0, BOEM anticipates that future offshore wind activities in the geographic analysis area, combined with ongoing activities and reasonably foreseeable activities other than offshore wind, would result in overall **moderate beneficial** impacts.

In addition to the beneficial economic activity from regional offshore wind development, BOEM anticipates **minor** adverse impacts associated with future offshore wind activities combined with ongoing activities, reasonably foreseeable environmental trends, and planned actions other than offshore wind. Future offshore wind activities are expected to affect commercial and for-hire fishing businesses and marine recreational businesses (tour boats, marine suppliers) primarily through cable emplacement, noise and vessel traffic during construction, and the presence of offshore structures during operations. These IPFs would temporarily disturb fish and marine mammal species and displace commercial or for-hire fishing vessels, potentially resulting in conflict over other fishing grounds, increased operating costs, and lower revenue for marine industries and supporting businesses. The long-term presence of offshore wind structures would also affect these marine industries due primarily to increased navigational constraints and risks as well as potential gear entanglement and loss.

3.6.2. Consequences of Alternative A

Effects on demographics, employment, and economics due to Alternative A alone include population gain or loss due to the Proposed Action workforce needs; housing needs for Proposed Action workforce; job creation; tax revenues, payroll, and other Proposed Action expenditures; and other funds provided by Vineyard Wind in connection with the Proposed Action. Other effects include economic activity generated within the study area through spending by Proposed Action employees or vendors; payment of personal income taxes by the Vineyard Wind workforce; and spending by governments, based upon income received from Vineyard Wind in connection with the Proposed Action.[13]

Economic effects may occur in the recreation, tourism, and commercial fishing sectors, as discussed below in the analysis of individual IPFs. Impacts on commercial fisheries may in turn affect the economic health as well as the cultural identity and values—and therefore the well-being—of individuals and communities that identify as "fishing" communities. Impacts on recreation and tourism could affect the economic health of businesses and individuals that serve tourists and seasonal residents.

Alternative A alone could have a broader economic impact than indicated by its payroll and expenditures due to its position as the nation's first large-scale offshore wind energy project. Comments from companies in the offshore wind industry have noted that the approval of the Proposed Action would encourage and support continued investment in other offshore wind projects and the creation of a domestic supply chain for the offshore wind industry in the eastern United States.

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on demographic, employment, or economic characteristics:

- Overall size of project (approximately 800 MW) and number and position of WTGs;
- The extent to which Vineyard Wind hires local residents and obtains supplies and services from local vendors;
- The port(s) selected to support construction, installation, and decommissioning in addition to the MCT;
- The port(s) selected to support operations and maintenance in addition to Vineyard Haven Harbor and the MCT; and
- The design parameters that could impact commercial fishing and recreation and tourism since impacts on these activities affect employment and economic activity.

In regards to demographics, jobs and economic activity, Alternative A's beneficial impacts on employment and the economy in the geographic analysis area are highly dependent on assumptions regarding the percent of workers, materials, equipment, vessels, and services that can be locally sourced.

In the COP, Vineyard Wind provided a University of Massachusetts at Dartmouth study with Vineyard Wind's anticipated range of spending statewide and in southeastern Massachusetts to allow formulation of estimated economic contributions (Borges, Goodman, et al. 2017, available in COP Volume III, Appendix III-L; Epsilon 2020b).[14] The analysis includes a base and high scenario; the high scenario assumes that a larger proportion of employees, vendors, and supplies come from Massachusetts. This impact assessment evaluates the "base" scenario, as a conservative measure, because the supply chain is not fully developed. Vineyard Wind provided no estimates of jobs or spending that the Proposed Action would generate outside of Massachusetts.

Vineyard Wind's economic impact study estimates that the Proposed Action would directly support the following employment in Massachusetts alone:

1. Under the base scenario: 1,100 FTE job years (one job year is the equivalent of one person working for one year) during construction and installation. In addition to these temporary jobs, an estimated 80 FTE jobs lasting 25 years are anticipated during operations and maintenance. Multiplying the 80 FTEs over 25 years, the study concludes that operations would result in 2,000 FTE job years; therefore, direct employment would total 3,100 FTE job years.

[13] As defined in the COP: "Indirect impacts result from the suppliers of the wind farm purchasing goods and services as a result of the direct spending on the project. Because these impacts measure interactions among businesses, they are often referred to as supply-chain impacts. Induced impacts result from the spending of employees directly involved in the development, construction, and operations of the wind farm, as well as the spending of employees of the wind farm's suppliers within the region. These induced effects are often referred to as consumption-driven impacts." (COP Volume III, Appendix III-L; Epsilon 2020b)

[14] As described in Section 3.1.1 of Borges et al. (2017a, available in COP Volume III, Appendix III-L; Epsilon 2020b), the base and high economic impact scenarios reflect different levels of spending by Vineyard Wind in Massachusetts and southeast Massachusetts.

2. Under the high scenario: 1,552 FTE job years during construction and installation, and an estimated 81 FTEs over 25 years (or 2,025 FTE job years) during operations and maintenance. Total direct employment would be 3,577 FTE job years.

A recently completed Massachusetts workforce assessment that supports Vineyard Wind's job estimates projects possible statewide job creation from construction of offshore wind projects totaling 1,600 MW (twice the Proposed Action's approximately 800 MW facility), using the Jobs and Economic Development Impact method developed by the National Renewable Energy Laboratory (NREL) (BCC et al. 2018). The assessment provides a low estimate, which assumes that no major components are manufactured within Massachusetts, and a high estimate, which assumes that a small amount of secondary foundation parts are sourced locally. The NREL study estimated that construction of 1,600 MW of offshore wind power would generate 2,279 to 3,171 direct employees, 2,315 to 3,618 indirect employees, and 2,284 to 3,063 induced employees (as measured in full-time equivalent job-years).

Estimates of job and economic activity generation from other available studies are comparable but somewhat different from Vineyard Wind's estimates. The Georgetown Economic Services report estimates lower direct job support but higher indirect and induced job support within Massachusetts, resulting in a total estimate (for the base or lower scenario) of about 600 fewer jobs. The study estimates job creation from construction of 1,600 MW of offshore wind energy would support 1,026 direct job-years, 2,872 indirect job years, and 2,372 induced job-years.

The NREL study also estimates that during operations and maintenance, the 1,600 MW of offshore wind power would support employment totaling 964 employees (low scenario, including 140 direct, 581 indirect, and 242 induced jobs). This is comparable to Vineyard Wind's estimates of base case direct jobs (80 jobs), but substantially higher than Vineyard Wind's estimated base case indirect/induced jobs (89 indirect/induced jobs). Job factors generated by the Georgetown Economic Services study generated results closer to Vineyard Wind's, estimating that operations for 1,600 MW of offshore wind development (twice the size of the Vineyard Wind 1 Project) would support 178 direct jobs (about twice the number projected by Vineyard Wind) and 289 indirect/ induced jobs (about three times Vineyard Wind's projections).

Tables 3.6-3, 3.6-4, and 3.6-5 summarize Vineyard Wind's 2017 estimates of construction-phase employment, tax revenues (state and local), and operations-phase economic activity (respectively) generated by Alternative A alone within Massachusetts. At least 97 percent of direct job creation and 93 percent of indirect/induced job creation are anticipated to be located within southeastern Massachusetts, as opposed to elsewhere in Massachusetts. Vineyard Wind's base estimate for construction-related expenditures on materials and supplies within Massachusetts is $177 million, 59 percent of which they anticipate to be from suppliers within southeastern Massachusetts (Borges, Goodman, et al. 2017).

Ninety percent of the 80 jobs required for operations and maintenance would be located at the Operations and Maintenance Facilities in Tisbury (Borges, Goodman, et al. 2017), an approximate 1 percent increase in existing employment in Dukes County (Appendix F). Indirect and induced jobs would also be located in southeastern Massachusetts and other portions of the state. Vineyard Wind would also use the MCT for repair and maintenance.

Vineyard Wind estimates that job compensation (including benefits) would average between $88,000 and $96,000 for the construction phase, with occupations including engineers, construction managers, trade workers, and construction technicians (Borges, Goodman, et al. 2017). Operations and maintenance occupations would consist of wind technicians, plant managers, water transportation workers, and engineers, with average annual compensation of approximately $99,000 (COP Volume III, Appendix III-L; Epsilon 2020b). A study from the New York Workforce Development Institute provided estimates of salaries for jobs in the wind energy industry that concur with Vineyard Wind's projections. Anticipated salaries range from $43,000 to $96,000 for trade workers and technicians, $65,000 to $73,000 for ships' crew and officers, and $64,000 to $150,000 for managers and engineers (Gould and Cresswell 2017).

Revised employment and economic estimates for the base scenario were provided by Vineyard Wind in March 2020 and are reflected in the COP (COP Volume III, Appendix III-L; Epsilon 2020b). The COP indicates a possible reduction in the number of WTGs installed. If Vineyard Wind were to install 57, 14 MW WTGs instead of the potential 100, 8 MW WTGs initially evaluated, the reduced spending associated with the reduced number of turbines would decrease employment, tax revenue, and economic output. Compared to the 8 MW WTG technology evaluated in the DEIS, use of 14 MW WTGs and 1 to 2 ESPs would have the following effects (Vineyard Wind 2020c):

- Reduction in employment generated by Proposed Action construction: 14 percent reduction in Massachusetts statewide, 15 percent reduction in southeastern Massachusetts;
- Reduction in economic output, expenditures, and economic value-added generated by the Proposed Action operation and maintenance: 9 percent reduction in both Massachusetts and southeastern Massachusetts; and
- Reduction in tax revenue from the Proposed Action during Development, Construction, and First-Year Operations and Maintenance: 7.5 percent reduction.

Vineyard Wind notes two other revisions to the original Proposed Action that would affect the Proposed Action's economic impact. First, the delay in obtaining federal authorization for the Proposed Action has increased the development and pre-construction period by 2 years. This delay increases the Project's development, pre-construction, and consultant jobs by an estimated 100 FTEs per year for 2 years, regardless of the development scenario selected. The 2-year permitting delay approximately offsets changes in employment and non-labor expenditures of the 57 WTG scenario compared to the pre-construction and construction estimates for the 100 WTG scenario provided in the Vineyard Wind COP (COP Volume III, Appendix III-L; Epsilon 2020b). However, the estimated 100 FTE jobs supported by Vineyard Wind during the 2-year delay also apply to the 100 WTG scenario. The employment and economic impacts for the 100 WTG scenario would be greater than the 2017 estimates when accounting for the 2-year permitting delay.) Secondly, although the estimate of jobs during operations and maintenance is based on a 25-year operational period, Vineyard Wind is requesting a 30-year operational period, which would increase the overall FTE jobs and expenditures (Vineyard Wind 2020c). The 2.2-acre (8,903 m^2) increase in the proposed substation site area (Section 2.1.1.1) would not change the analysis of impacts on demographics, employment, and economics.)

In addition to job creation growth of local businesses, and tax revenues, the following economic benefits would result from voluntary investments Vineyard Wind has committed to upon negotiation of a Power Purchase Agreement (COP Volume III, Appendix III-Q; Epsilon 2020b), including:

- HCA between Vineyard Wind and the Town of Barnstable: Vineyard Wind would provide $16 million to the town (Town of Barnstable 2018);
- Windward Workforce Program: $2 million one-time payment to support programs that recruit and train residents of Massachusetts, especially southeast Massachusetts, for jobs in the offshore wind industry, in partnership with high schools, community colleges, and other organizations;
- Offshore Wind Industry Accelerator Fund: an up-to $10 million one-time payment to attract investments in ports, manufacturing facilities, and technology development for offshore wind;
- Resiliency and Affordability Fund: $1 million annually for 15 years to promote and support low-income ratepayers, clean energy projects, and coastal energy resiliency in Bristol, Dukes, Nantucket, and Barnstable counties; and
- Community Benefit Agreement between Vineyard Wind and the Vineyard Power Cooperative: the parties would regularly consult to identify opportunities to benefit Martha's Vineyard residents, including investment in the Tisbury Working Waterfront, job training funding, and use of the Resiliency and Affordability Fund (Vineyard Power Undated).

Vineyard Wind estimates that the Windward Workforce Program, Offshore Wind Industry Accelerator Fund, and the first year of the HCAs would result in 53 direct and 125 indirect jobs during the first year that the funds are implemented (COP Volume III, Appendix III-L; Epsilon 2020b).

Because of the lower employment, economic output, and tax revenue, the 14 MW WTG option described above is the scenario that would produce the smallest beneficial economic benefit. As a conservative measure, this section evaluates the economic impacts of the Proposed Action with the 14 MW WTG option and the lower or base scenario employment estimates. Alternative A alone would have long-term**, minor beneficial** impacts on employment and economic activity in the geographic analysis area, based upon anticipated short-term and modest long-term job creation, expenditures on local businesses, generation of tax revenues, and provision of grant funds. Alternative A alone would have **negligible** impacts on demographics and housing within the geographic analysis area. As noted in Section 3.6.1.2, the growth of the overall offshore wind industry is anticipated to result in **moderate beneficial** impacts to employment and economics in the geographic analysis area. Alternative A alone would be part of but would not change the magnitude of the impact. Accordingly, in context of reasonably foreseeable environmental trends, the combined impacts of ongoing and planned actions, including Alternative A, is anticipated to have **moderate beneficial** impacts to employment and economics in the geographic analysis area.

Impacts from Alternative A alone resulting from the IPFs identified below would include beneficial, long-term impacts from port utilization and expansion and vessel traffic and adverse impacts from short-term increases in noise during construction, cable emplacement, land disturbance, and the long-term presence of offshore lighting and structures. Alternative A alone would contribute to impacts through all the IPFs named in Section 3.6.1.1. The most impactful beneficial IPFs would be increased port utilization and vessel traffic, while the most impactful adverse IPFs would be the long-term presence of offshore structures, which would affect businesses accustomed to navigating in the offshore lease areas.

The impacts of Alternative A, when combined with past, present, and reasonably foreseeable activities, would be similar to the No Action Alternative. If the proposed Project is not approved, it is assumed that the energy demand that the proposed Project would have filled would likely be met by other projects in remaining areas of the Massachusetts, Rhode Island, and/or New York leases. Although the impacts from a substitute project may differ in location and time, depending on where and when offshore wind facilities are built out to meet the remaining demand, the nature of impacts and the total number of WTGs would be similar either with or without the Proposed Action. In other words, future offshore wind facilities capable of generating 9,404 MW are anticipated to be built in the RI and MA Lease Areas, although, in the absence of the Proposed Action, none would be built before 2022.

Energy Security/Generation: The impacts on demographics, employment, and economics from this IPF under Alternative A alone would include a long-term contribution to energy security and resiliency for the geographic analysis area, providing economic benefit through a stable supply of energy. Alternative A would have long-term, localized, **minor beneficial** impacts on demographics, employment, and economics. Future offshore wind activities would have similar contributions as the Proposed Action, but on a larger scale. In context of reasonably foreseeable environmental trends, combined energy security/generation impacts on demographics, employment, and economics from ongoing and planned actions, including Alternative A, would be regional, long-term, and **minor beneficial**, due to the increased renewable energy generation.

Light: Nighttime lighting for vessels in transit and in the offshore work area would occur when Project construction or maintenance takes place at night. Vessel lighting would be visible from shore primarily for ships in transit; vessel lighting at the offshore work area may be discernible from shore from very limited locations (COP Volume III, Appendix III.H.a; Epsilon 2020b). Short-term vessel lighting is not anticipated to discourage tourist-related business activities and would not impact other businesses; therefore, lighting from Alternative A alone would have short-term, **negligible** impacts. Vessel lighting from other offshore wind projects would have similar impacts as Alternative A, but at different locations and times. If lighting from Proposed Action vessels occurred simultaneously the impacts of this lighting on demographics, employment, and economics would also be short-term, and **negligible**.

The permanent aviation safety lighting required for Alternative A's WTGs could be visible from beaches and coastal locations on Martha's Vineyard and Nantucket, possibly affecting employment and economics in these areas if the lighting discourages visits or vacation home rental or purchases in coastal locations where Alternative A's WTG lighting is visible. As described in Section 3.9, lighting from all Alternative A's WTGs could theoretically be visible from onshore locations. Vineyard Wind has committed to voluntarily implement ADLS as described in Section 3.6.1 as a voluntarily measure. ADLS would activate Alternative A's WTG lighting when aircraft approach the Vineyard Wind 1 Project WTGs, which is expected to occur less than 0.1 percent of annual nighttime hours. Even without ADLS, the presence of aviation safety lighting on the WTGs for Alternative A alone is anticipated to have a long-term, **negligible** impact on demographics, economics, and employment in the geographic analysis area. Use of ADLS would reduce the already negligible impact.

In addition, as stated in Section 3.6.1.2, the lights on 652 WTGs associated with other offshore wind projects (in addition to 57 WTGs from Alternative A—a total of 709 out of the 775 WTGs) could also be visible. Section 3.9 concludes that lighting from Alternative A, in the context of reasonably foreseeable environmental trends, would have a minor impact on recreation and tourism. Due to the potential effect on businesses providing recreational and tourist services, combined lighting impacts on demographics, employment, and economics from ongoing and planned actions, including Alternative A, would be continuous, long-term, and **negligible** to **minor**. If implemented for offshore wind projects other than the Proposed Action, ADLS would reduce the economic impacts associated with WTG lighting to **negligible**.

New cable emplacement and maintenance: Offshore cable emplacement for Alternative A alone would impact approximately 233 acres (0.9 km^2) of seafloor, which could temporarily impact commercial/for-hire fishing businesses during cable installation and infrequent maintenance. Cable installation would reduce income and increase costs for vessels that need to relocate away from work areas and disrupt fish stocks near the installation locations. Cable emplacement would have larger impacts on fixed gear fisheries, which are highly territorial. It would be far more difficult for fixed-gear operators to adapt to removal of gear during cable installation. Therefore, installation of Alternative A's cables would have localized, short-term, **minor** impacts on employment and economics, due to impacts on the commercial/for hire fishing business.

All specific cable locations associated with future offshore wind projects have not been identified in the waters offshore from the geographic analysis area with the exception of the Vineyard Wind 2 Project cable, which would use the same offshore cable corridor as Alternative A. Overall, cable emplacement for offshore wind activities included in the analysis for the No Action Alternative (including Alternative A) would impact over 3,398 acres (13.8 km^2). Based on the assumptions in Appendix A, these cables would not be installed simultaneously with the Proposed Action; therefore, in context of reasonably foreseeable environmental trends, combined new cable emplacement impacts on demographics, employment, and economics from ongoing and planned actions, including Alternative A, would be short-term and **minor**.

Noise: The contribution of Alternative A alone to noise from G&G survey activities, operations and maintenance, pile driving, trenching, and vessels would affect certain marine business activities associated with commercial/for hire fishing, marine sightseeing, and recreational boating. As a result, Alternative A alone would have intermittent, short-term, **negligible** impacts on visitors, workers, and residents. Pile driving associated with Alternative A and the Revolution and Sunrise Wind projects could overlap in 2023 and 2024, which could result in greater noise impacts on fish and marine mammals, as discussed in Sections 3.3, 3.4, and 3.10.

The onshore construction noise activities from Alternative A are not anticipated to overlap in location with other offshore wind projects. Therefore, in context of reasonably foreseeable environmental trends, combined noise impacts on demographics, employment, and economics from ongoing and planned actions, including Alternative A, would be short-term and **negligible,** resulting from impacts on the fishing and sightseeing businesses that rely on these species.

Port Utilization, Expansion, and Maintenance/Dredging: Alternative A alone would diversify jobs and revenues in the geographic analysis area's Ocean Economy sector. In particular, the Proposed Action would enlarge and require new skills within the marine construction sector. It would also support demand for marine transportation and service workers for tug and other vessel charters, dockage, fueling, inspection/repairs, provisioning, and crew work (Borges, Goodman, et al. 2017). These jobs within the Ocean Economy sector would be concentrated in Bristol County (site of the MCT), but could also be created in counties with other port facilities described in Section 3.6.1. The Proposed Action could temporarily compete with the commercial fishing industry for marine workers and services during construction, potentially increasing labor and service costs and encouraging vessel owners to use services in ports not supporting offshore wind development. The New Bedford Port Authority has worked with MassCEC and Vineyard Wind to develop supply chain and support opportunities, with a focus on fishing businesses (Mitchell 2020). The supply of marine transportation workers in Bristol County (Table F.2-9 in Appendix F) provides an experienced workforce with relevant skills.

Vineyard Wind anticipates that the Operations and Maintenance land-based facilities would use an existing industrial marina facility in Vineyard Haven that provides marine vessel services and houses multiple businesses. As noted in Section 3.6.1, Duke's County, which contains Martha's Vineyard, has a high proportion of seasonal housing, as well as an older population and higher proportion of employment in visitor services than the Massachusetts statewide average. The Operations and Maintenance Facility at Vineyard Haven would help to diversify the island's economy by providing a source of skilled, year-round jobs. Jobs may be filled by island residents or off-island residents who commute by ferry.

The Proposed Action would make use of the state's ongoing investment in the MCT at the Port of New Bedford, as well as private investments at Vineyard Haven Harbor, but was not itself the impetus for any such investments. Port upgrades at the MCT were undertaken in support of the Massachusetts/ Rhode Island offshore wind industry as a whole. Employment and economic benefits of Alternative A alone at the Port of New Bedford, Vineyard Haven, and other ports within the geographic analysis area would have long-term, **minor beneficial** impacts.

Other offshore wind energy activity would provide business activities at the same ports as Alternative A as well as other ports within the geographic analysis area. As noted in Section 3.6.1.1, port investments are ongoing and planned in response to offshore wind activity. Therefore, in context of reasonably foreseeable environmental trends, combined port utilization and expansion impacts on employment and economics from ongoing and planned actions, including Alternative A, would be long-term and **moderate beneficial**.

Presence of structures: The impacts of Alternative A alone on employment and economics for marine-based businesses (i.e., commercial and for-hire recreational fishing businesses, offshore recreational businesses, and related businesses) would be continuous, long-term, and **negligible** to **minor**. The offshore structures resulting from Alternative A, including 57 WTGs, 2 ESPs, and approximately 109 acres (0.4 km^2) of hard coverage for WTG and ESP foundations and cable protection could affect commercial fisheries and for-hire recreational fishing due to impacts such as entanglement and gear loss/damage, navigational hazard and risk of allisions, fish aggregation, habitat alteration, effort displacement, and space use conflicts. Similar impacts would affect recreational fishing and marine sightseeing (Section 3.9).

Hard coverage would include approximately 31 acres (0.1 km^2) of scour protection around WTG and ESP foundations that could have fish aggregation and reef effects, which would also provide new opportunities for recreational fishing.

As described in Section 3.9.2, portions of all of Alternative A's WTGs could theoretically be visible from beaches and coastal locations on Martha's Vineyard, Nantucket, and Cape Cod, in addition to portions of all WTGs associated with other offshore wind projects. As discussed in Section 3.6.1.1, views of WTGs could have impacts on businesses serving the recreation and tourism industry. Considering the distance from shore and limited visibility of the offshore structures from residences, coastlines, and businesses, operation of Alternative A alone would have **negligible** impacts on economics due to property value impacts and viewshed impacts on recreational and tourist businesses.

For the entire geographic area, up to 795 offshore structures and 1,029 acres (4.2 km^2) of hard protection for structures and cabling would affect employment and economics by affecting marine-based businesses. Due to the presence of offshore wind structures, Alternative A, in the context of reasonably foreseeable environmental trends when combined with ongoing and planned actions, would have a long-term, **moderate** impact on demographics, employment, and economics, due to impacts on commercial and for-hire recreational fishing, for-hire recreational boating, and associated businesses.

Vessel Traffic and Vessel Collisions: The Proposed Action would generate vessel traffic in the Port of New Bedford, Vineyard Haven Harbor, and other ports supporting project construction. Increased vessel traffic would increase the use of port and marine businesses, including tug services, dockage, fueling, inspection/repairs, and provisioning. The vessel traffic generated by Alternative A alone would result in increased business for marine transportation and supporting services in the geographic analysis area with continuous, short-term, and **minor beneficial** impacts during construction and decommissioning, and **negligible beneficial** impacts during operations. Vessel traffic associated with the Proposed Action could also result in temporary, periodic congestion within and near ports, leading to potential delays and an increased risk for collisions between vessels, which would result in economic costs for vessel owners. As a result of potential delays resulting from increased congestion and increased risk of damage from collisions, Alternative A would have continuous, short-term, and **minor** impacts during construction and **negligible** impacts during operations.

In the context of reasonably foreseeable environmental trends, increased vessel traffic from ongoing and planned actions, including Alternative A, would produce demand for supporting marine services, with beneficial impacts on employment and economics during all project phases, including **minor** to **moderate beneficial** impacts during construction and decommissioning and **negligible beneficial** impacts during operations. In the context of reasonably foreseeable environmental trends, increased vessel traffic congestion and collision risk from ongoing and planned actions, including Alternative A, would have long-term, continuous impacts on marine businesses during all project phases, with **minor** impacts during construction and decommissioning and **negligible** impacts during operations.

Land Disturbance: Construction of Alternative A would require onshore cable installation and substation construction in Barnstable. The employment and economic impact of Alternative A caused by disturbance of businesses near the onshore cable route and substation construction site would result in localized, short-term, **minor** impacts. Land disturbance associated with other projects are unlikely to occur in close spatial and temporal proximity to Alternative A. Therefore, in context of reasonably foreseeable environmental trends, combined land disturbance impacts on demographics, employment, and economics from ongoing and planned actions, including Alternative A, would be short-term and **minor** due to the short-term and localized disruption of onshore businesses.

Climate Change: Section 3.6.1.1 identifies possible economic implications of climate change within the geographic analysis area. Alternative A alone would result in a small reduction in or avoidance of emissions from power generation resulting in a long-term, **negligible beneficial** impact on demographics, employment, and economics. Planned offshore wind activities offshore from the geographic analysis area would have similar contributions as Alternative A, but at a larger scale. In context of reasonably foreseeable environmental trends, combined climate change impacts on demographics, employment, and economics from ongoing and planned actions, including Alternative A would thus be long-term, and **minor beneficial**.

In summary, BOEM anticipates that Alternative A alone would have **negligible** impacts on demographics within the study area. While it is likely that some workers would relocate to the area due to the Proposed Action, the volume of workers needed compared to the current population and housing supply is such that the change would be negligible.

Alternative A alone would have **minor beneficial** impacts on employment and economics due to job creation, expenditures on local businesses, tax revenue and grant funds provided by Vineyard Wind, and the support for additional regional offshore wind development that would result from construction of the Proposed Action. Construction would provide jobs and revenue, but considering the short duration of the construction period, would have a minor beneficial impact on employment and economics. Beneficial impacts on employment and economics would increase (but would remain minor, based on the definitions in Table 3-1) if the local hiring plan mitigation measure outlined in Appendix D became a condition of COP approval. Employment and expenditures during operations and maintenance would be long-term, lasting 25 to 30 years, but would be of modest magnitude, limiting the beneficial impact. Tax revenues and grant funds likewise would be modest in magnitude, but would provide a beneficial impact on public expenditures and development of the local job force and supply chain for offshore wind. Decommissioning of Alternative A would also have **minor beneficial** impacts on employment and economics due to the construction activity necessary to remove the wind facility structures and equipment. Upon completion of decommissioning, the jobs and economic activity generated by operations and maintenance would cease and the Proposed Action would no longer produce employment and other revenues.

The IPFs associated with Alternative A alone would result in impacts on commercial/for hire fishing businesses that range from **negligible** to **moderate**. Impacts on individual and community well-being in fishing communities are anticipated to be directly correlated to the level of impact anticipated to the commercial fishing industry. These impacts would be concentrated in communities identified as having medium to high commercial fishing engagement and reliance. Impacts on commercial fishing during construction would impact not only the commercial fishing industry itself, but also the onshore businesses that depend upon the local seafood supply, including seafood markets and processing. Overall, the impacts on commercial fishing and onshore seafood businesses would have **moderate** impacts on employment and economic activity for this component of the analysis area's economy. Although commercial fishing is a small component of the regional economy, it is important to the economy and identity of local communities within the region.

The IPFs associated with Alternative A alone would also result in impacts on certain recreation and tourism businesses that range from **negligible** to **moderate**. As noted in Section 3.9, construction and operation of Alternative A may have **minor** to **moderate** impacts on recreation and tourism in the geographic analysis area. Overall, these impacts on recreation and tourism would have **minor** impacts on employment and economic activity for this component of the analysis area's economy. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.6.1.2.

In the context of other reasonably foreseeable environmental trends, impacts resulting from individual IPFs would range from **negligible** to **moderate** impacts and **negligible** to **moderate beneficial** impacts. Considering all the IPFs together, BOEM anticipates that the overall impacts associated with ongoing and planned actions including Alternative A would result in **minor** impacts and **moderate beneficial** impacts on demographics, employment, and economics in the geographic analysis area. The main drivers for this impact rating include minor adverse and beneficial impacts associated with investment in offshore wind, job creation and workforce development, infrastructure improvements, aviation hazard lighting on WTGs, new cable emplacement and maintenance, the presence of structures, vessel traffic and collisions during construction, and land disturbance. Alternative A would contribute to the overall impact rating primarily through short-term impacts from vessel traffic and potential collisions, long-term impacts from the presence of structures (WTGs and ESPs), and beneficial impacts from new hiring and economic activity. **Moderate** impacts are anticipated due to impacts on commercial and for-hire recreational fishing (Section 3.10.2), but these impacts would only be a component of the overall impacts on this resource.

Thus, the overall impacts would likely qualify as **minor** impacts because it is expected that these impacts would not disrupt normal or routine demographic characteristics, employment, or economic activity in the geographic analysis area—or that, in the case of temporary economic activity specifically associated with construction, any such changes would generally revert to pre-construction conditions following construction completion. In addition, in the context of reasonably foreseeable environmental trends, ongoing and planned actions including Alternative A would have **moderate beneficial** impacts on demographics, employment, and economics due to a notable and measurable benefit from construction and operations-phase employment and economic improvement. While the significance level of impacts would remain the same, BOEM could increase the beneficial impacts with the local hiring plan conditioned as part of the COP approval (Appendix D).

3.6.3. Consequences of Alternative C, D1, D2, and E

The impacts of Alternatives C, D1, D2, and E on demographics, employment, and economics are summarized below:

- The differences in the WTG layouts used for Alternatives C, D1, and D2 would not alter the Project's impacts on demographics, employment, and economics described for Alternative A.
- Under Alternative E, the Project would include up to 84 WTGs using a combination of 9 to 10 MW WTGs, compared to 57 14 MW WTGs for Alternative A. Under Alternative E, the manufacture, installation, and decommissioning of the larger number of turbines would result in a slightly larger construction workforce, labor spending, total direct expenses, and tax revenues than Alternative A. The increased number of WTGs (compared to the 14 MW option) would incrementally complicate navigation through the WDA, marginally increasing potential adverse economic impacts on commercial fishing and recreational businesses that navigate through the WDA. As a result, the impacts of Alternative E on demographics, employment, and economics, both beneficial and adverse, would be marginally stronger than those of Alternative A, but would likely remain similar in overall impact.

Accordingly, the impacts resulting from individual IPFs associated with Alternatives C, D1, D2, and E on demographics, employment, and economics would be the same as those of the Alternative A alone: **negligible** to **moderate** impacts due to the IPFs discussed above, along with **negligible** to **minor beneficial** impacts due to new hiring and economic activity.

In the context of reasonably foreseeable environmental trends, the impacts resulting from individual IPFs associated with ongoing and planned actions including Alternatives C, D1, D2, and E would be very similar to those of Alternative A: **negligible** to **moderate** impacts on demographics, employment, and economics along with **negligible** to **moderate beneficial** impacts due to new hiring and economic activity.

The overall impacts of each alternative combined with ongoing and planned actions on this resource within the geographic analysis area would be of the same level as under Alternative A—**minor** and **moderate beneficial**. This impact rating is primarily driven by the construction, installation, and presence of offshore wind structures, the increased risk of vessel allision and collision, and the job creation and economic activity resulting from offshore wind development.

3.6.4. Consequences of Alternative F

The direct and indirect impacts of Alternative F on demographics, employment, and economics would vary based on the width of the transit lane and the underlying layout used, as discussed below. The primary differences between Alternative A and the combination of Alternative F and Alternative A would be the establishment of a 2- or 4-nautical-mile-wide northern transit lane through the WDA resulting in the following changes in impacts for Alternative F alone, as compared to Alternative A alone:

- Reduced impacts from IPFs related to allisions and collisions due to the presence of a transit lane parallel (or crossing perpendicularly) to the northwest-southeast predominant orientation of WTGs. Implementation of a 4-nautical-mile transit lane would reduce impacts more than a 2-nautical-mile transit lane, but neither reduction in impact would change the overall **minor** impact on demographics, employment, and economics from this IPF.
- Marginally reduced impacts from IPFs related to the visibility of WTG structures and hazard lighting because some of Alternative A's WTGs would be farther from shore, reducing the number of WTGs and lights potentially visible, and thereby incrementally reducing the economic impacts of visible WTGs. This would include 16 WTGs moved farther away from shore if a 2-nautical-mile transit lane were established, and 34 WTGs located farther away if a 4-nautical-mile transit lane were established. Due to the distance between the WDA and onshore viewers, these relocations would not change the **negligible** impacts of visual changes on demographics, employment, and economics already described for Alternative A.

Impacts from other IPFs under Alternative F with Alternative A would remain the same as or substantially similar to those of Alternative A. As a result, impacts resulting from individual IPFs associated with Alternative F alone would have **negligible** to **moderate** impacts on demographics, employment, and economics; as well as **minor beneficial** impacts.

The primary differences between Alternative D2 and the combination of Alternative F with Alternative D2 would be the establishment of a 2- or 4-nautical-mile-wide northern transit lane through the WDA resulting in the following changes in impacts, compared to Alternative D2 alone:

- Increased impacts from IPFs related to allisions and collisions. The presence of a 2-mile or 4-mile transit lane would facilitate travel for vessels seeking to pass through the entire WDA, reducing the likelihood of allisions and collisions. However, the northwest-southeast transit lane orientation would differ from the east-west orientation of Vineyard Wind 1 WTGs and the preferred east-west orientation of commercial fishing. In addition, some commercial and recreational fishing and boating could occur within the transit lane. These impacts would lead to increased navigational complexity and risk of allisions or collisions within the WDA, with resulting impacts on demographics, employment, and economics. The overall impact magnitude would remain **minor**, with both a 2-nautical-mile and 4-nautical-mile-wide transit lane.
- Marginally reduced impacts from IPFs related to the visibility of WTG structures and hazard lighting because some of Alternative D2 WTGs would be farther from shore, reducing the number of WTGs and lights potentially visible, thereby incrementally reducing the economic impacts of visible WTGs. This would include 16 WTGs moved farther away from shore if a 2-nautical-mile transit lane were established, and 33 WTGs located farther away if a 4-nautical-mile transit lane were established. Due to the distance between the WDA and onshore viewers, these relocations would not change the **negligible** impacts of visual changes on demographics, employment, and economics already described for Alternative D2.

Impacts from other IPFs under Alternative F alone with Alternative D2 would remain the same as or substantially similar to those of Alternative D2 alone. As a result, impacts resulting from individual IPFs associated with Alternative F would have **negligible** to **moderate** impacts on demographics, employment, and economics, as well as **minor beneficial** impacts.

The impacts from the combination of Alternative F alone with Alternatives C, D1, and E are expected to be similar to those described for Alternative F with Alternative A.

In the context of reasonably foreseeable environmental trends, ongoing and planned actions, including Alternative F, would have **negligible** to **moderate** impacts on demographics, employment, and economics. The beneficial impacts would remain **moderate,** but would be smaller than under Alternative A. The overall impacts of Alternative F on this resource in the context of reasonably foreseeable environmental trends would be of the same level as under

Alternative A—**minor** and **moderate beneficial**. This impact rating is primarily driven by the construction, installation, and presence of offshore wind structures, and job creation and economic activity.

BOEM has qualitatively evaluated the collective impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. To the extent additional transit lanes are implemented in the future outside the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located farther from shore, similar to the proposed Project under Alternative F. As a result, establishment of these additional transit lanes could require longer vessel trips for all phases of future projects and longer timeframes time for cable installation. Collectively, these effects would result in greater impacts on demographics, employment, and economics than if Alternative F were not implemented, due to increased impacts on marine species of interest to marine businesses from cable installation and increased risk of vessel collision (due to the increased distance traveled and potential funneling within the transit lanes). See Section 3.10 for details on the potential economic impacts of Alternative F on commercial fishing.

In addition to longer vessel transits and cable routes, if all transit lanes suggested by RODA were implemented, the technical capacity of offshore wind power generation in the RI and MA Lease Areas would be reduced. Total state demand for the RI and MA Lease Areas is assumed to be 9.4 GW, and technical capacity of the RI and MA Lease Areas is assumed to be 12.7 GW. Approximately 775 WTGs are needed to meet existing state demand: 57, 14 MW WTGs from the Proposed Action, plus 717, 12 MW WTGs for the remainder of the proposed offshore wind projects in the RI and MA Lease Areas. Implementing six transit lanes with width of 2-nautical-miles each would remove about 156 positions out of 1,059 possible foundation positions across the RI and MA Lease Areas. Total technical capacity would be reduced, but it could still be feasible to place 775 WTGs, plus ESPs, to meet the state demand.

Implementing six transit lanes with width of 4-nautical-miles each would remove about 322 positions, leaving about 737 positions available. Of those positions, approximately 14 would be occupied by ESPs, leaving 723 positions for WTGs, or 54 WTGs short of meeting the assumed demand. The technical capacity of the remaining area after implementation of the 4-nautical-mile transit lanes would be approximately 8.9 GW, leaving approximately 0.5 GW (500 MW) of state demand unfulfilled. The total technical capacity loss in the RI and MA Lease Areas based upon 4-nautical-mile transit lanes would be approximately 3.3 GW.

BOEM assumes that installation of 22 GW of Atlantic offshore wind capacity is reasonably foreseeable through 2030, and 9.4 GW is likely to be within the RI and MA Lease Areas—the lease areas closest to the geographic analysis area (Appendix A, Section A-4). As explained in Section 3.6.1.1, BOEM anticipates a moderate beneficial impact on employment and economics based on projected investment, employment, and economic output resulting from east coast offshore wind.[15] Supply chain jobs and investment could occur nationwide, but AWEA anticipates an overall concentration of economic and employment impacts in coastal states hosting offshore wind development (AWEA 2020). Based on the significant share of the RI and MA Lease Area in the anticipated offshore wind development, BOEM finds it reasonable to anticipate a moderate beneficial impact within the geographic analysis area. A reduction in offshore wind installation in the RI and MA Lease Area due to required transit lanes would result in a proportional reduction in local jobs and investment related to offshore wind installations—i.e., reductions in the required workforce, vessels, staging and port facilities, and logistical support needed to survey, plan, install, maintain, and operate offshore wind installations. Loss of local, direct workforce would also reduce induced economic activity and job creation, while loss of the local construction activity for offshore wind would result in loss of indirect income and employment for supporting businesses. This would reduce beneficial economic impacts in the geographic analysis area in comparison to the impacts of all other action alternatives.

3.6.5. Comparison of Alternatives

Most alternatives alone are effectively identical in terms of the level of impact on demographics, employment, and economics. As compared to Alternative A, Alternative E alone would have slightly larger beneficial employment

[15] Section 3.6.1.1 explains some of the anticipated economic activity for Atlantic offshore wind by 2030, including the following: (1) $1.3 billion in announced wind energy-related investments in ports, vessels, and manufacturing facilities in Atlantic coast states; (2) national projections of $14.2 billion in economic output and $7 billion in value added (base case assumptions); and (3) national projections of 45,500 to 61,000 FTE jobs (base case assumptions) (AWEA 2020; Georgetown Economic Services 2020).

and economic impacts due to increased construction workforce, labor spending, total direct expenses, and tax revenues; and slightly larger employment and economic impacts associated with navigation complexity for commercial and for-hire recreational fisheries. Alternative F would have smaller impacts on employment, and economics, due to reduced impacts associated with structures and vessel collision, and incrementally smaller beneficial impacts due to potentially lower levels of job creation and economic investment in offshore wind. Furthermore, in context of reasonably foreseeable environmental trends, impacts would be slightly lower under Alternative F with Alternative A layout and slightly higher under Alternative F with the Alternative D2 layout than under the maximum-case scenario in other action alternatives. However, the overall impact of any action alternative when combined with other planned actions would likely be very similar. See Table 2.4-1 for a comparison of alternative impacts.

3.6.6. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. The Preferred Alternative incorporates the local hiring plan and all other mitigation measures listed in Appendix D. The Preferred Alternative would incrementally reduce the economic effects resulting from visual impacts compared to Alternative A alone by relocating the six WTG locations closest to shore to the southern lease area. The Preferred Alternative would also reduce the maximum possible number of WTGs for the proposed Project from 100 to no more than 84, incrementally reducing the impact of offshore structures on marine-based businesses, but not changing the overall magnitude of economic impact on the commercial and for-hire recreational fishing or on marine-related recreation businesses (Sections 3.9 and 3.10). The maximum-case scenario (minimum beneficial economic impact) for the proposed Project would still involve installation of 57, 14 MW WTGs. In all other aspects, the Preferred Alternative would be identical to Alternative A in impacts for demographics, employment, and economics including the new hiring and economic activity, and the implementation of the local hiring plan. Accordingly, impacts of the Preferred Alternative alone would remain of the same level as for Alternative A (**negligible** to **moderate** along with **negligible** to **minor beneficial**).

3.7. Environmental Justice

3.7.1. No Action Alternative and Affected Environment

This section discusses existing conditions in the geographic analysis area for environmental justice, as described in Table A-1 and shown on Figure A.7-7 in Appendix A. Specifically, this includes the counties where proposed onshore infrastructure and potential port cities are located, as well as the counties in closest proximity to the WDA: Barnstable, Bristol, Dukes, and Nantucket counties, Massachusetts; and Providence and Washington counties, Rhode Island. Table 3.7-1 describes baseline conditions and the impacts, based on the IPFs assessed, of ongoing and future offshore activities other than offshore wind, which is discussed below.

EO 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). By definition, beneficial impacts are not environmental justice impacts; however, this section identifies beneficial effects on environmental justice communities, where appropriate, for completeness.

EO 12898 directs federal agencies to actively scrutinize the following issues 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 to 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 minority populations (i.e., residents who are non-white, or who are white but have Hispanic ethnicity) when they comprise over 50 percent of an affected area. Environmental justice analyses must also address affected areas where minority or low-income populations are "meaningfully greater" than the minority percentage in the "reference population"—the population of a larger area, often an entire state (USEPA 2016). 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 Commonwealth of Massachusetts identifies an environmental justice community as U.S. Census block groups that meet one or more of the following criteria (Commonwealth of Massachusetts 2017):

- 25 percent of households within the census block group have a median annual household income at or below 65 percent of the statewide median income for Massachusetts;
- 25 percent or more of the residents are minority; or
- 25 percent or more of the residents have English Isolation.[16]

Using this definition, environmental justice communities in the Massachusetts portion of the geographic analysis area are clustered around larger cities and towns, and occur in Hyannis, New Bedford, and Fall River, which contain populations that meet both the income and minority criteria. Environmental justice communities meeting the minority population criterion are present in south-central Nantucket County near Cisco and the Nantucket airport. In Dukes County, communities meeting the income and minority/English isolation criteria for environmental justice are present near Vineyard Haven, and a minority population is present near Aquinnah. Additional environmental justice communities occur on Cape Cod and scattered throughout southeastern Massachusetts.

CEQ and USEPA guidance do not define "meaningfully greater" in terms of a specific percentage or other quantitative measure. Similarly, the state of Rhode Island does not provide specific thresholds. For Rhode Island, this FEIS defines an environmental justice community as one or more block groups that either (1) meet USEPA's "50 percent" criterion for race, or (2) are in the 80th or higher percentile for minority and/or low-income status as compared to the state population. Environmental justice communities meeting the minority and income criteria are present within and near Providence. Appendix F provides maps of environmental justice community locations in the geographic analysis area based on the above criteria.

Table 3.7-2 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 Massachusetts and Rhode Island.[17] The non-white population percentage and percentage of population living under the poverty level have generally increased since 2000 in nearly all study area jurisdictions.

In addition to the geographic locations of environmental justice communities, low-income workers are found within the commercial fishing industry, service industries that support tourism, and supporting industries. Ongoing development supports employment and economic development that may benefit some lower income workers. Offshore projects would provide continuing support for employment in marine trades, vessel and port maintenance, and supporting industries.

The average annual wage in Massachusetts in 2015 was $66,932 for workers employed in fishing, and $58,103 for workers employed in seafood processing; the average for all workers statewide was $66,716. Fishing industries generally provided higher wages and income than the tourist and recreation components of the ocean economy (Borges, Colgan, et al. 2017). Commercial fishing is within the "living resource" sector of NOAA's Coastal Economy index, which includes fishing, seafood processing, seafood markets, aquaculture, and fish hatcheries

[16] Indicates households defined by the U.S. Census as being English Language Isolated or that do not include an adult who speaks only English or English very well (Commonwealth of Massachusetts 2017).

[17] Available census data for 2000 and 2010 do not distinguish between white and non-white Hispanic individuals, and do not compare median household income at the state and block group levels. The percentage of non-white individuals and the percentage of the population with incomes below the federal poverty level ("Percentage of Population in Poverty") are therefore used as proxies for "minority" and "low income" environmental justice criteria.

(NOAA 2018g). Average wages for living resource sector employees were higher than the county average for all workers in Bristol, Dukes, and Washington counties, and lower than the county average in Barnstable, Nantucket, Providence, and Suffolk (New York) counties. Table 3.7-3 shows the 2017 average wage for living resource industry employees in southeastern Massachusetts, Rhode Island, and Suffolk County, New York (the counties within the environmental justice study area, as well as those containing the commercial fishing ports most exposed to the RI and MA Lease Areas[18]). Many workers within this industry sector are self-employed. Income data for self-employed workers are not available, but average gross receipts for self-employed workers suggests that their average income is less than the average wage in most counties.

The average wage obscures the range of income levels, which include higher income workers (ship's captains and managers), as well as lower-level or unskilled workers who earn substantially less than the average wage, including some self-employed individuals. Many lower level workers in the living resource sector likely qualify as low-income, and would thus be vulnerable to disruptions to employment in the commercial fishing industry.

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 to environmental justice populations include loss of significant cultural or historical resources and the impact's relation to other cumulatively significant impacts (USEPA 2016). BOEM is holding ongoing government-to-government consultations on the proposed Project with the Narragansett Indian Tribe, the Mohegan Indian Tribe of Connecticut, the Mashantucket (Western) Pequot Tribe, the Mashpee Wampanoag Tribe of Massachusetts, the Shinnecock Indian Nation of New York, the federally recognized Wampanoag Tribe of Gay Head (Aquinnah). BOEM is also consulting with these federally recognized Native American Tribes, and the state-recognized Chappaquiddick Wampanoag Tribe, as part of the National Historic Preservation Act (NHPA) Section 106 review for the proposed Project (Appendix C, Sections C.1.2.3 and C.1.2.4).

No existing study identifies all cultural practices potentially affected by offshore wind projects in the geographic analysis area; however, tribes have provided some information on such practices. Concerns of the Mohegan Tribe of Connecticut, Mashantucket Pequot Tribal Nation, Narragansett Indian Tribe, Mashpee Wampanoag Tribe, and Wampanoag Tribe of Gay Head (Aquinnah) include effects on marine mammals, other marine life, and submerged ancient landforms in Nantucket Sound. One tribe emphasized the importance of open ocean views to the east during sunrise, as well as the night sky, while others emphasized their long historical association with the sea and islands off southern New England and the critical role of fishing and shellfish gathering.

As part of the NHPA Section 106 process, the state-recognized Chappaquiddick Wampanoag Tribe submitted information on traditional cultural practices related to Chappaquiddick Island and other portions of Martha's Vineyard (Gordon 2019). The tribe's ancestors managed the lands through building rock fences, scheduled burns to control certain plants, and clearing of coastal inlets to ensure salt water could filter into ponds to maintain fish and shellfish breeding grounds. The tribe considers multiple locations on Chappaquiddick Island to have value as traditional cultural places based on current and past cultural practices that include (but are not limited to) burial grounds; ceremonial viewsheds associated with sunrise, sunset, and full moon ceremonies; and locations associated with ceremonies for hunting of marine and land mammals. Other significant associations are for subsistence activities (berry picking, fishing, clamming, and hunting), harvesting of marine mammals such as whales and seals, and collecting sage, wild indigo, and healing herbs. The tribe's input has resulted in identification of the Chappaquiddick Island Traditional Cultural Property (TCP), a newly identified resource potentially eligible for the National Register of Historic Places (NRHP). The Chappaquiddick Island TCP includes eight distinct locations, identified by the state-recognized Chappaquiddick Wampanoag Tribe and associated with the activities identified above, which are contributing elements of the Chappaquiddick Island TCP (BOEM 2020a). In addition, the state-recognized Chappaquiddick Wampanoag Tribe also asserts that submerged ancient landforms on the OCS offshore of Martha's Vineyard and Nantucket are integral to its cultural practices (Thomas 2020).

[18] Section 3.10.1 provides information on the value of port landings harvested from the RI and MA Lease Areas; see Table 3.10-3a and Table 3.10-3b in Appendix B.

The federally recognized Wampanoag Tribe of Gay Head (Aquinnah) identified certain unencumbered views from the Gay Head cliffs as important cosmological and ceremonial cultural resources (BOEM 2014d). The Tribal Historic Preservation Officer has noted the importance of the tribal lands on the west side of Martha's Vineyard that include Gay Head Cliffs, designated as a National Natural Landmark by the National Park Service. The Aquinnah Cultural Center at the top of the Gay Head Cliffs provides a place for the federally recognized Wampanoag Tribe of Gay Head (Aquinnah) to preserve, interpret, and document the Aquinnah Wampanoag history and culture.

In January 2021, investigations to identify historic properties conducted as part of a separate offshore renewable energy project identified the Vineyard Sound-Moshup's Bridge TCP off the coast of Martha's Vineyard (Vineyard Wind 2021b). The Vineyard Sound-Moshup's Bridge TCP was identified through a review of publicly available literature and interviews with the Wampanoag Tribe of Gay Head (Aquinnah) Tribal Historic Preservation Officer. The TCP comprises the lands and waters of Vineyard Sound, the Elizabeth Islands, Gay Head Cliffs, Nomans Island, and the associated shallow water shoals along the southwestern and western shores of Martha's Vineyard (Vineyard Wind 2021b). These areas are culturally significant to the Wampanoag Tribe of Gay Head (Aquinnah) due to their association with Moshup (Maushop), a giant, teacher, leader, transformer, and culture hero in Wampanoag traditions. Moshup is an important figure in the history of the Wampanoag Tribe of Gay Head (Aquinnah), in particular his role in the creation of Vineyard Sound and separating Noepe from the Elizabeth Islands; gathering the Aquinnah people around him at his home at the Aquinnah (Gay Head) Cliffs and feeding and teaching the Aquinnah people; and forming Nomans Island and the shoals between Aquinnah and Cuttyhunk as part of Moshup's Bridge (Vineyard Wind 2021b).

3.7.1.1. Future Offshore Wind Activities (without Proposed Action)

BOEM expects future offshore wind development 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. As stated in Section A.8.1 in Appendix A, 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 communities. However, environmental justice communities 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.

Table A-4 in Appendix A identifies 12 future offshore wind projects other than the Proposed Action that could be constructed off the coast of Massachusetts and Rhode Island. Possible overlapping construction periods as estimated in Table A-4 in Appendix A could result in up to four projects under construction at one time. Vineyard Wind 1 construction could be supported by three ports near environmental justice communities: the ports of Providence, Quonset-Davisville, and New Bedford. Although beyond the scope of this analysis, the Massachusetts Clean Energy Center identified 18 waterfront sites in Massachusetts that may be available and suitable for use by the offshore wind industry (MassCEC 2017a, b), which may include others in close proximity to environmental justice communities. Deepwater Wind has committed to improvements to Rhode Island ports in support of the Revolution Wind Project (Kuffner 2018).

Based on the assumed construction schedule presented in Table A-6 in Appendix A, projects within the geographic analysis area for environmental justice populations would have overlapping construction periods beginning in 2022 and continuing through 2030. As stated in Section A.8.1, during the construction phase, total emissions of criteria pollutants (nitrogen dioxide$_2$, sulfur dioxide, carbon monoxide [CO], particulate matter with diameters 10 microns and smaller [PM_{10}], particulate matter with diameters 2.5 microns and smaller [$PM_{2.5}$], and volatile organic compounds) would be approximately 44,795 tons throughout the air quality geographic analysis area. This area is larger than the environmental justice geographic analysis area, extending from the coastline out to, and including, the offshore work areas for the RI and MA Lease Areas. Thus, a large portion of the emissions would not be generated near environmental justice communities, but along the vessel transit routes and at the offshore work areas. Emissions of nitrogen oxides and CO are primarily due to diesel construction equipment, vessels, and commercial vehicles.

Emissions would vary spatially and temporally during construction phases even for overlapping projects. Emissions from vessels, vehicles, and equipment operating in ports could affect environmental justice communities adjacent or close to those ports. 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 ports would comprise a small proportion of total emissions from those facilities. Therefore, air emissions during construction would have small, short-term, variable impacts on environmental justice communities 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 communities would be less.

As explained in Section A.8.1 in Appendix A, operations activities under the No Action Alternative would generate approximately 650 tons per year of criteria pollutants, primarily nitrogen oxides (482 tons per year) and CO (123 tons per year). Emissions would largely be due to vessel traffic related to operations and maintenance 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 port-based equipment operating within and near the three ports identified above would affect environmental justice communities. Therefore, during operations of offshore wind projects, the air emissions volumes resulting from port activities are not anticipated to be large enough to have impacts on environmental justice communities.

The power generation capacity of offshore wind could potentially lead to lower regional air emissions by displacing fossil fuel plants for power generation, resulting in potential reduction in regional greenhouse gas (GHG) emissions, as analyzed in further detail in Appendix A, Section A.8.1, Air Quality. A 2019 study found that nationally, exposure to fine particulate matter from fossil fuel electricity generation in the US 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). Although not specific to power generation, average population-weighted PM2.5 and nitrogen dioxide concentrations in Massachusetts were highest for urban non-Hispanic black populations and urban Hispanic populations, respectively (Rosofsky et al. 2017).

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 measurable benefits measured in health costs and reduction in loss of life due to displacement of fossil fuel power generation (Buanocore et al. 2016). Environmental justice populations in Massachusetts 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.

Light: The view of nighttime aviation warning lighting required for offshore wind structures could have impacts on economic activity in locations where lighting is visible, by affecting the decisions of tourists or visitors in selecting coastal locations to visit. Service industries that support tourism are a source of employment and income for low-income workers. Impacts on tourism are anticipated to be localized, not industry-wide (Section 3.9) so would have little impact on environmental justice populations. Lighting on WTGs could also affect cultural and historic resources, including views of night sky and the ocean that are important to Native American tribes. Section 3.8 evaluates visual impacts on historic and cultural resources.

As additional offshore wind projects become operational, the nighttime lighting would be visible from a greater number of coastal locations. The aviation hazard lighting from approximately 709 (out of 775) WTGs could potentially be visible from beaches and coastal areas in the environmental justice geographic analysis area, depending on vegetation, topography, weather, and atmospheric conditions; up to 34 of the WTGs could be less than 15 miles (24 kilometers) from the coast. Aviation hazard lighting is evaluated as part of the discussion of visual impacts on recreation and tourism in Section 3.9.1. The impacts on recreation and tourism-related economic activity, if any, would be long term and continuous, and could, in turn, have impacts on environmental justice populations, specifically low-income employees of tourism-related businesses.

Lighting impacts would be reduced if the emerging technology of ADLS is used. ADLS lighting would be activated only when an aircraft approaches (Section 3.6.1). For Alternative A, this was estimated to occur during less than 0.1 percent of total annual nighttime hours (Section 3.9.2). Depending on exact location and layout of offshore wind projects other than Alternative A, ADLS would likely result in similar limits on the frequency of WTG aviation warning lighting use. This technology, if used, would significantly reduce the impacts of lighting.

New cable emplacement/maintenance: Cable emplacement for wind projects offshore from the geographic analysis area for environmental justice would result in about 3,400 acres (13.7 km^2) of seafloor disturbance. Specific cable locations have not been identified offshore from the geographic analysis area with the exception of the Vineyard Wind 2 Project cable, which would use the same offshore cable corridor as the proposed Project. Assuming future projects use installation procedures similar to those proposed in the Vineyard Wind COP, cable emplacement could displace other marine activities for a period of 1 day to several months within cable installation areas.

As described in Sections 3.6.1 and 3.10.1, cable installation 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 the commercial and for-hire fishing businesses could temporarily adjust their operating locations to avoid revenue loss, the impacts would be greater if multiple cable installation or repair projects are underway offshore of the environmental justice geographic analysis area at one time. Business impacts could affect environmental justice populations due to the potential loss of income or jobs by low-income workers in the commercial fishing industry. In addition, cable installation and maintenance could temporarily disrupt subsistence fishing, resulting in short-term, localized impacts on low-income residents and tribal members who rely on subsistence fishing as a food source, as well as tribal members for whom fishing and clamming is also a cultural practice.

As noted in Section 3.8, cable emplacement could damage submerged ancient landforms that may have cultural significance to Native American tribes as part of ancient and ongoing tribal practices, and as portions of a landscape occupied by their ancestors. Disturbance and destruction of even a portion of an identified submerged landform could degrade or even eliminate the value of these resources as potential repositories of archaeological knowledge and cultural significance to tribes. If these landforms are disturbed during offshore cable emplacement, the impact on the cultural resource would be permanent, resulting in a disproportionately large and adverse impact on the affected Native American tribes.

Noise: As described in greater detail in Section 3.6 and 3.10, noise from site assessment G&G survey activities, pile driving, trenching, and vessels is likely to result in temporary revenue reductions for commercial fishing and marine recreational businesses that operate in the areas offshore from the geographic analysis area for environmental justice populations. Construction noise, especially site assessment G&G surveys and pile driving, would affect fish and marine mammal populations, with impacts on commercial and for-hire fishing and marine sightseeing businesses. 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/for-hire fishing and marine tours.

The localized impacts of offshore noise on fishing could also have an impact on subsistence fishing by low-income residents and tribal members. In addition, noise would affect some for-hire fishing businesses or marine sightseeing businesses, as these visitor-oriented services are likely to avoid areas where noise is being generated due to the disruption for the 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. As indicated in Table A-4 in Appendix A, the projects within the Rhode Island and Massachusetts lease areas offshore from the geographic analysis area for environmental justice could have a total of 775 offshore WTGs and 20 ESPs installed within a 6- to 10-year period. The impacts of offshore noise on marine businesses and subsistence fishing would have short-term, localized impacts on low-income workers in marine-dependent businesses as well as residents or tribal members who practice subsistence fishing and clamming, resulting in impacts on environmental justice populations. It is anticipated that most offshore construction activities would take place in the summer due to more favorable weather conditions. Thus, commercial/for-hire fisheries and marine-sightseeing businesses most active in the summer would likely be impacted more than those active during the winter.

Onshore construction noise would temporarily inconvenience visitors, workers, and residents near sites where onshore cables, substations, or port improvements are installed to support offshore wind. Impacts would depend upon the location of onshore construction in relation to businesses or environmental justice communities. Impacts on environmental justice communities could be short term and intermittent, similar to other onshore utility construction activity.

Noise generated by offshore wind staging operations at ports would potentially have impacts on environmental justice communities if the port is located near such communities. Within the geographic analysis area for environmental justice populations, the ports of Providence, Quonset-Davisville, and New Bedford are within or near environmental justice communities. The noise impacts from increased port utilization would be short term and variable, limited to the construction period, and would increase if a port is used for multiple offshore wind projects during the same time period. Noise impacts would be reduced if intervening buildings, roads, or topography lessen the intensity of noise in nearby residential neighborhoods, or if noise reduction mitigations are used for motorized vehicles and equipment.

Port utilization, Expansion: The ports of Providence, Quonset-Davisville, and New Bedford are within or near environmental justice communities. Impacts would result from increased air emissions and noise generated by port utilization or expansion (see discussions above under Air Emissions and Noise).

Port use and expansion resulting from offshore wind would have beneficial impacts on employment at ports. As described in Section 3.6, port improvements and expansions designed to support offshore wind development are underway or completed. For ports within older urban centers in the geographic analysis area, such as Providence and New Bedford, recent economic trends have resulted in declining employment in manufacturing industries. Port utilization for offshore wind would have short-term beneficial impacts for environmental justice populations during construction and decommissioning, resulting from employment opportunities, the support for other local businesses by the port-related businesses, and employee expenditures. Beneficial impacts would also result from port utilization during offshore wind operations, but these impacts would be of lower magnitude.

Presence of structures: As described in Sections 3.6 and 3.9, the offshore structures required for offshore wind projects, including WTGs, ESPs, and offshore cables protected with hard cover, would affect employment and economic activity generated by marine-based businesses.

Commercial fishing businesses would need to adjust routes and fishing grounds to avoid offshore work areas during construction, and to avoid WTGs and ESPs 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. For-hire recreational fishing businesses would also need to avoid construction areas and offshore structures. Businesses that serve HMS recreational fishing are more likely to be affected, because these fisheries are more likely to overlap areas where offshore wind development would occur (as opposed to other fisheries, which tend to occur closer to shore). Sailing races (including, but not limited to the Transatlantic Race, Marion to Bermuda Race, and Newport Bermuda Race) may need to be re-routed, affecting the shore-based businesses that serve these interests.

A decrease in revenue, employment, and income within commercial fishing and marine recreational industries is likely to impact low -income workers, resulting in impacts on environmental justice populations. The impacts during construction would be short term, and would increase in magnitude when multiple offshore construction areas exist at the same time. As many as four offshore wind projects could be under construction simultaneously in the waters offshore from the geographic analysis area. Impacts during operations would be long term and continuous, 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 marine activity and supporting businesses, WTGs are anticipated to provide new opportunity for subsistence and recreational fishing, through fish aggregation and reef effects, and to provide attraction for recreational sightseeing businesses, potentially benefitting subsistence fishing and low-income employees of marine-dependent businesses.

Views of offshore WTGs could also have impacts on individual locations and businesses serving the recreation and tourism industry, based on visitor decisions to select or avoid certain locations. Because the service industries that support tourism are a source of employment and income for low-income workers, impacts on tourism would also result in impacts on environmental justice populations. As stated in Section 3.9.1, portions of all 775 WTGs associated with the No Action Alternative could potentially be visible from shorelines, depending on vegetation, topography, weather, and atmospheric conditions. While WTGs could be visible from some shoreline locations in the geographic analysis area, WTGs would not dominate offshore views, even when weather and atmospheric conditions allow views. The impact of visible WTGs on recreation and tourism is likely to be limited to individual decisions by some visitors and is unlikely to affect most shore-based tourism businesses or the geographic analysis area's tourism industry as a whole (Section 3.9.1). Therefore, views of offshore WTGs are not anticipated to result in impacts on environmental justice populations, specifically low-income employees of tourism-related businesses.

Views of WTGs would affect cultural and historic resources, including the Gay Head Cliffs on the southwestern coast of Martha's Vineyard and the Chappaquiddick Island TCP, that are important to Native American tribes. The tribes affected by visual impacts on these resources include, but are not limited to, the state-recognized Chappaquiddick Wampanoag Tribe and the federally-recognized Wampanoag Tribe of Gay Head (Aquinnah). BOEM has consulted with Native American tribes for whom these views are culturally important, as part of the review under the NHPA Section 106. Section 3.8 provides evaluations of visual impacts on historic and cultural resources.

Traffic, vessels: Offshore wind construction and decommissioning and, to a lesser extent, offshore wind operation would generate increased vessel traffic. As stated in Section 3.9, future offshore wind projects would result in vessel traffic from as many as four projects under construction concurrently offshore from the geographic analysis area. Vessel traffic for each project is not known; however, as an example, the Vineyard Wind 1 Project is projected to generate an average of seven daily vessel trips between ports and offshore work areas over the entire construction phase, and an average of 18 vessel trips daily during peak construction activity (COP Volume III, Appendix III-I, Section 5.2.2; Epsilon 2020b).

The volume of vessel traffic during construction would complicate marine navigation in the offshore construction areas and create the potential for vessel congestion and reduced capacity within and near the ports that support offshore construction, with potential competition for berths and docks. The temporary impacts on commercial fishing or recreational boating would affect all local boaters, and would not have disproportionate impacts on residents or businesses within areas identified as environmental justice communities; however, the impact may be of greater magnitude for individuals who fish for subsistence (or as part of tribal practices) or members of environmental justice communities who depend on jobs in commercial/for-hire fishing or marine recreation (including seafood processing and packing industries) for their livelihood. Simultaneous development of multiple offshore wind projects could increase port-related vessel congestion. However, the impacts could be reduced by appropriate port planning and preparation. The MCT was built to support the wind industry. The City of New Bedford's plan details goals for improvement of facilities to support commercial fishing, shipping, and recreational boating, providing for the full range of port users in addition to offshore wind (Sasaki et al. 2016). Therefore, use of the MCT and nearby industrial sites to support the proposed Project would not displace existing businesses.

Accordingly, vessel traffic generated by offshore wind project construction would have short-term, variable impacts on environmental justice communities due to the impacts on jobs, income, and subsistence fishing resulting from impacts on marine businesses, port congestion, and availability of berths. The magnitude of impact would depend upon the navigation patterns and the extent of facility preparation and planning at the particular port. In addition to the temporary impacts related to navigation and port availability, the increased need for marine transportation to support offshore wind could have beneficial impacts on environmental justice populations through the provision of jobs and support of businesses.

Land disturbance: Offshore wind development would require onshore cable installation, substation construction or expansion, and possibly expansion of shore-based port facilities. Depending on siting, land disturbance could result in temporary, localized, variable disturbances of neighborhoods and businesses near cable routes and construction sites due to typical construction impacts such as increased noise, dust, traffic, and road disturbances. Potential short-term, variable impacts on environmental justice communities could result from land disturbance, depending upon the particular location of onshore construction for each offshore wind project.

3.7.1.2. Conclusions for 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 proposed 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 population growth and new development; resulting traffic increases and industrial development, possibly increasing emissions near environmental justice communities; loss of industrial waterfront uses, with attendant loss of jobs and reduction of pollution; ongoing commercial fishing, seafood processing and tourism industries that provide job opportunities for low-income residents; and construction-related air pollutant emissions and noise when these occur near environmental justice communities. BOEM anticipates that the environmental justice impacts of these ongoing activities would be **minor**.

Reasonably foreseeable trends affecting environmental justice populations, other than offshore wind, include changes in the commercial fishing and seafood processing industries due to climate change and environmental stress; growing recreational and tourism components for coastal economies; new development that would result in increased motor vehicle emissions; historically industrial waterfront locations promoting start-up space and commercial re-use of industrial space; and continued pressure to balance development pressure and coastal activity with protection of air and water quality. BOEM anticipates that the impacts of these trends and planned actions on environmental justice populations would be **minor**. BOEM expects the combination of ongoing and planned actions other than offshore wind to result in **minor** impacts on environmental justice populations, driven primarily by the continued operation of existing marine industries, especially commercial fishing, recreation/tourism, and shipping; increased pressure for environmental protection of coastal resources; and the loss of industry in historically industrial port areas.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area combined with ongoing activities and reasonably foreseeable activities other than offshore wind would result in overall **moderate** adverse impacts. This reflects short-term impacts on minority and low-income communities from cable emplacement, construction-phase noise and vessel traffic, and the long-term presence of offshore structures, which could affect marine-dependent businesses, resulting in job losses for low-income workers. Construction-related port activities could have impacts on environmental justice communities near ports through air emissions, traffic, or noise. This rating also reflects disproportionately large and adverse impacts on several Native American tribes resulting from long-term impacts on culturally important ocean views and permanent impacts on submerged ancient landforms (Section 3.8). Additionally, this rating reflects short-term impacts on some species of clams (Section 3.2), finfish (Section 3.3), and marine mammals (Section 3.8) of importance to the values and practices of certain Native American tribes. If implemented for projects other than the proposed Project, ADLS would reduce the impacts of WTG lighting on environmental justice communities associated with important ocean views, but would not change the moderate impacts described above for the No Action Alternative as a whole. In addition, mitigation measures identified through future NHPA Section 106 consultation for each project could reduce impacts on resources with value to tribes.

BOEM also anticipates that the impacts associated with future offshore wind activities in the geographic analysis area would result in beneficial effects on minority and low income populations through economic activity and job opportunities in marine trades and the offshore wind industry. Additional beneficial effects may result from reductions in air emissions if offshore wind displaces energy generation using fossil fuels. Beneficial effects are noted for completeness, but are not part of an environmental justice review under federal guidelines (CEQ 1997); therefore, are not assigned a level of significance.

3.7.2. Consequences of Alternative A

Effects on environmental justice communities would occur when the Proposed Action's adverse effects on other resources, such as air quality, water quality, employment and economics, cultural resources, recreation and tourism, commercial fishing, or navigation, are felt disproportionately within environmental justice communities, due either to the location of these communities in relation to the Proposed Action or to their higher vulnerability to impacts.

The following proposed-Project design parameters (Appendix G) would influence the magnitude of environmental justice impacts:

- Two different maximum-case scenarios for environmental justice are used:
  - The maximum-case scenario for income and employment (for Alternative A and all other action alternatives) would be 100, 8 MW WTGs (the maximum number of WTGs allowed in the PDE), which would have the maximum impact on vessel traffic for commercial and recreational fishing and boating and related industries that provide employment for low-income workers.
  - The maximum case scenario for visual impacts—including visual impacts that affect businesses that employ workers from environmental justice communities, as well as visual impacts on cultural resources of significance to Native American tribes—for Alternative A and all other action alternatives would be 57, 14 MW WTGs. The height of the 14 MW WTGs (a hub height of 473 feet AMSL and a maximum blade tip height of 837 feet [255 meters] AMSL) would increase the number and portion of WTGs visible from cultural resources, as explained in Section 3.8.
- Increasing the size of the proposed substation by 2.2 acres (less than 0.1 km^2), as described in Chapter 2, would not change the analysis of environmental justice impacts for Alternative A and all other action alternatives. The expanded substation area would be within a designated industrial area and would not have meaningfully different effects on environmental justice communities, compared to those of the substation evaluated in the DEIS.
- The time of year during which construction occurs. Vineyard Wind has scheduled onshore construction to take place after Labor Day and before Memorial Day, outside of the busiest tourist season on Cape Cod, Martha's Vineyard, and Nantucket. If the construction schedule were to shift such that construction of the cable landfalls and OECRs occurred during the tourist season, the proposed Project would have substantially larger impacts on land use, employment and economics, and recreation and tourism—impacts that could disproportionately affect environmental justice communities (COP Volume I, Section 4.1; Epsilon 2020a); and
- The ports chosen for construction support in addition to the MCT, and the improvements needed at those additional ports due to the proposed Project.

Impacts on environmental justice communities from Alternative A, resulting from the IPFs below, would include impacts on cultural practices and values of Native American tribes resulting from views of WTGs; impacts on shellfish, fish, and marine mammal populations; and damage to submerged ancient landforms. Impacts of Alternative A also include impacts on low-income workers in the commercial/for-hire fishing, marine recreation, and supporting industries. The most impactful IPFs would likely include cable emplacement, vessel traffic during construction and the presence of offshore structures, due to the potential impacts of these IPFs on submerged landforms, marine businesses (fishing and recreational), views of WTGs, and subsistence fishing.

The impacts of the Proposed Action in addition to ongoing activities, future non-offshore wind activities, and other future offshore wind activities are listed by IPF in Table 3.7-1. The most impactful IPFs would include visual impacts on resources with cultural (including tribal) significance; damage to ancient landforms with cultural importance for Native American tribes; temporary, higher levels of air emissions and noise at port facilities near environmental justice communities; and the presence of offshore structures that would affect navigation and commercial fishing. Beneficial economic effects would result from port utilization and reduction in air emissions, resulting from displacement of fossil fuel electricity generation.

Air emissions: Emissions at offshore locations would have regional impacts, with no disproportionate impacts on environmental justice communities. However, environmental justice communities 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. Alternative A's contributions to increased air emissions at the ports of Providence, Quonset-Davisville, New Bedford, and Vineyard Haven, near environmental justice communities, are not specifically evaluated; however, as stated in Section A.8.2.1 in Appendix A, overall air emissions impacts would be **minor** during Proposed Action construction, operations, and decommissioning, with the greatest quantity of emissions produced at the offshore WDA and by vessels transiting from ports to the WDA. Alternative A would use the MCT at the Port of New Bedford as its primary port staging location for construction. The Port has other industrial and commercial sites with less intense uses, as well as major roads, separating residential neighborhoods from the MCT (Sasaki et al. 2016). Therefore, air emissions from the Alternative A alone would have **negligible** impacts on environmental justice communities near the ports.

Net reductions in air pollutant emissions resulting from Alternative A 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 A.8.1 in Appendix A, by displacing fossil fuel power generation, 800 MW of offshore wind power generation could potentially avoid estimated annual health costs of $170 to $379 million, and annual mortality of 11 to 39 deaths that would otherwise have resulted from air emissions. As noted in Section 3.7.1.1, minority and low income populations are disproportionately impacted by emissions from fossil fuel power plants nationwide and by higher levels of air pollutants within Massachusetts. Therefore, Alternative A alone could benefit environmental justice communities by displacing fossil fuel power generating capacity within or near the geographic analysis area.

As noted in Section A.8.1 in Appendix A, other offshore wind projects using ports within the geographic analysis area for environmental justice populations would overlap with the Vineyard Wind 1 Project operations phase, and short-term air quality impacts during the construction phase would be likely to vary from minor to moderate significance levels. The impacts at specific ports close to environmental justice communities cannot be evaluated because port usage has not been identified; however, most air emissions would occur at offshore locations rather than at the ports. In addition to air emissions at ports, offshore wind within the RI and MA wind lease areas would result in greater potential displacement of fossil fuel power generation than Alternative A alone. In the context of reasonably foreseeable environmental trends, combined air quality impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be **negligible** to **minor**, due to short-term emissions near ports. 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.

Light: As described in Section 3.9.2, nighttime aviation safety lighting on all of Alternative A's WTGs could be visible from coastal locations on Martha's Vineyard, Nantucket, and possible Cape Cod, depending on vegetation, topography, weather, and atmospheric conditions. As many as 17 of the Proposed Action's WTGs could be constructed within 15 miles (24 kilometers) of the shoreline, the area within which changes in visual conditions are more likely to result in impacts on recreation and tourism. Nighttime lighting would affect views of the horizon and the night sky from locations with historic and cultural importance to Native American tribes (Section 3.8). Vineyard Wind has committed to voluntarily implement ADLS. An ADLS would activate Alternative A's WTG lighting only when aircraft approach the Vineyard Wind 1 Project WTGs, which is expected to occur less than 0.1 percent of annual nighttime hours. As a result, the lighting of offshore structures from Alternative A alone would result in a long-term, continuous, **negligible** impact on environmental justice communities, as a result of the negligible impact on views important to Native American tribes and on the recreation/tourism economic sector that provides employment for low-income workers.

Aviation hazard lighting from 709 WTGs associated with the No Action Alternative and Proposed Action could potentially be visible from coastal locations. Section 3.9.2 concludes that the potential visibility of the additional aviation hazard lighting would result in a long-term, minor impact on recreation and tourism, reduced to negligible if ADLS is used. Additionally, the visual impact of night sky lighting would contribute to the disproportionately adverse, visual impact on cultural resources important to Native American tribes, described below under presence of structures. Accordingly, in context of reasonably foreseeable environmental trends, combined lighting impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be continuous, long-term and **moderate**, resulting from the anticipated disproportionate impacts on cultural resources important to Native American tribes. However, if implemented for projects other than the Proposed Action, ADLS would reduce the impacts on environmental justice communities associated with WTG lighting to **negligible**.

New cable emplacement/maintenance: Offshore cable emplacement for Alternative A would temporarily impact commercial/for-hire fishing businesses, marine recreation, and subsistence fishing during cable installation and infrequent maintenance. As noted in Sections 3.6.2, and 3.10.2, installation of Alternative A's cables would have short-term, localized, minor impacts on marine businesses (commercial fishing or recreation businesses) and subsistence fishing. Installation and construction of offshore components for Alternative A alone could therefore have a short-term, **minor** impact on low-income workers in marine businesses. The requirement described in Appendix D to engage with federally recognized Native American tribes within the geographic analysis area to increase awareness of, and potential participation in, proposed fishing compensation, trust, and innovation funds could marginally reduce impacts on tribe members in the commercial or recreational fishing industries; however the magnitude of these impacts would remain **minor**. Specific cable locations associated with future offshore wind projects have not been identified within the geographic analysis area for environmental justice populations with the exception of the Vineyard Wind 2 Project cable, which would use the same offshore cable corridor as the Proposed Action, but cable emplacement would impact over 3,398 acres (13.7 km^2). In context of reasonably foreseeable environmental trends, combined offshore cable emplacement impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be short-term and **minor** impact, resulting from the impact on subsistence fishing and employment and income from marine businesses.

As noted in Section 3.8, cable emplacement would disrupt submerged ancient landforms that hold cultural significance for Native American tribes. Marine geophysical remote sensing studies performed for the Proposed Action identified 35 submerged landform features (stream channel, lake, and estuarine landscape features) within the WDA and OECC. While the HRG and geotechnical studies did not find any direct evidence of pre-Contact period Native American cultural materials, the submerged landforms are considered culturally significant by regional Native American tribes as portions of a landscape occupied by their ancestors. Disturbance and destruction of even a portion of an identified submerged landform could threaten the value of these resources as potential repositories of archaeological knowledge and cultural significance to tribes. Vineyard Wind has voluntarily committed to removing one WTG placement location and rerouting the OECC and WDA inter-array cables to avoid 16 of the 35 submerged landforms identified in the WDA and OECC (COP Volume II-C; Epsilon 2019c). Construction of Alternative A would result in large-scale, permanent impacts on the remaining 19 submerged landforms. Vineyard Wind has committed to working with the consulting parties, Native American tribes, BOEM, and the Massachusetts Historical Commission (MHC) to develop a specific treatment plan for mitigating impacts on unavoidable submerged landforms. The additional mitigations to resolve impacts would be codified in a NHPA Section 106 Memorandum of Agreement. With implementation of a treatment plan agreed to by all parties, Section 3.8.2 concludes that the magnitude of impacts on the submerged landforms would nonetheless be major, due to reduced value and integrity of the submerged landscapes. As a result, cable emplacement would also result in **major** environmental justice impacts on the Native American tribes that consider the submerged landscapes to be part of their ancient and ongoing tribal practices, and as portions of a landscape occupied by their ancestors.

As with Alternative A, future offshore wind projects would likely be unable to avoid impacts on all submerged landforms, but BOEM would work with tribes and consulting parties to develop project-specific treatment plans. In context of reasonably foreseeable environmental trends, the combined cable emplacement impacts on cultural resources from ongoing and planned actions, including Alternative A, would have **major** disproportionate impacts on Native American tribes due to potential impacts on submerged landforms of cultural significance.

During the NHPA Section 106 consultations, the state-recognized Chappaquiddick Wampanoag Tribe also raised concerns regarding sediment plumes, coastal erosion, and impacts from cable installation from Alternative A on natural and cultural resources on Chappaquiddick Island. In particular, concerns were raised about potential increase in shoreline erosion along Chappaquiddick Island at the eastern end of Martha's Vineyard, which could impact traditional hunting, fishing, and shellfishing. The cable route for the Proposed Action would be at least 1,900 meters (6,230 feet) offshore from the shoreline. Section 3.1 concludes that the impacts of cable emplacement on sediment deposition and burial would be minor, based upon Vineyard Wind's sediment transport analysis to model the potential distribution of suspended sediment during dredging and cable installation (COP Volume III, Appendix III-A, Epsilon 2020b; Epsilon 2018c). The sediment model indicated that sediment deposition greater than 0.04 inch (1 millimeter) would be mostly limited to within approximately 328 feet (100 meters) of the cable centerline (COP Volume III, Appendix III-A, Epsilon 2020b).

Vineyard Wind also examined the likelihood of its project to contribute to coastal erosion, concluding that an offshore wind farm may alter wind- driven waves as they pass through the wind farm; however, such changes are likely to reduce wave energy and consequently are not expected to exacerbate shoreline erosion (BOEM 2020a Appendix C-3).

Accordingly, cable emplacement from Alternative A would have a **negligible** impact on fishing and shellfishing practices of the state-recognized Chappaquiddick Wampanoag Tribe due to coastal erosion and sediment deposition on Chappaquiddick Island. Multiple projects using the same OECC or causing sediment plumes to enter the same coastal habitat could cause repeated sedimentation of coastal habitats, but are not anticipated to be closer to the shoreline of Chappaquiddick Island than the Proposed Action. Therefore, in context of reasonably foreseeable environmental trends, the combined cable emplacement impacts of sediment deposition and burial on the Chappaquiddick Island coastline from ongoing and planned actions, including Alternative A, would likely be **negligible.**

Onshore construction includes installation of the onshore cable, primarily within public road and utility ROWs, and substation construction within a designated industrial area. Air emissions from onshore construction of Alternative A alone would be temporary and variable, with **negligible** impacts on environmental justice communities. The Proposed Action's onshore construction activities are not anticipated to overlap in location and time with the onshore cable installation and substation construction of other offshore wind projects. Onshore cable installation or substation construction for the Proposed Action and offshore wind projects would have a combined impact only if they occurred at the same time within or adjacent to environmental justice communities, increasing the level of resulting noise, dust, road disturbance and air emissions. In context of reasonably foreseeable environmental trends, combined onshore cable emplacement impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would be temporary and **negligible** to **minor**.

Noise: Noise from Alternative A construction (primarily pile driving) during offshore wind development would have short-term impacts on fish and marine mammals, as discussed in Sections 3.3, 3.4, and 3.10. These increased impacts would affect the fishing and sightseeing businesses that rely on these species, resulting in impacts on employment, income, and subsistence fishing (Sections 3.6.2, 3.9.2 and 3.10.2). As explained in Sections 3.6.2 and 3.9.2, the contribution of Alternative A alone to noise from site assessment G&G survey activities, operations and maintenance, pile driving, trenching, and vessels is anticipated to have short-term, intermittent, negligible impacts on visitors, workers, and residents. Therefore, Alternative A's construction noise would have short-term, **negligible** impacts on the members of environmental justice populations who rely on subsistence fishing or employment and income from marine businesses. Similarly, offshore construction noise would have **negligible** impacts on cultural practices of and values held by Native American tribes related to fish, shellfish, or marine mammal populations. The requirement described in Appendix D to share environmental monitoring data and reports, particularly those related to marine mammals, with federally recognized Native American tribes could help to address the tribes concerns about impacts to fish, shellfish, and marine mammal populations by providing documentation and the results of efforts to avoid, minimize, and/or mitigate impacts to culturally significant species.

The noise from multiple offshore survey and project construction activities (primarily G&G survey activity and pile driving) during offshore wind development would have also short-term impacts on fish and marine mammals over a wider area and longer time period, as discussed in Sections 3.3, 3.4, and 3.10. The increased impacts would affect the fishing and sightseeing businesses that rely on these species, resulting in impacts on employment, income, and subsistence fishing (Sections 3.6.2, 3.9.2, and 3.10.2). Accordingly, in context of reasonably foreseeable environmental trends, combined offshore noise impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be short-term and **negligible** to **minor**, resulting from the impacts on low-income employees of marine-dependent businesses and on the cultural practices of and values held by Native American tribes related to fish, shellfish, and marine mammal populations.

Noise generated by Alternative A's staging operations at ports would potentially have disproportionately high impacts on environmental justice communities if the port is located near such communities. Although no port expansion is proposed in connection with the Proposed Action, Alternative A would primarily use the Port of New Bedford and may also use the ports of Providence and Quonset-Davisville, all located near environmental justice communities. The Port of New Bedford has other industrial and commercial sites with less intense uses, as well as major roads, separating residential neighborhoods from the MCT (Sasaki et al. 2016); therefore, noise from Alternative A alone would have short-term, variable, **negligible** impacts on environmental justice communities near the ports. The noise impacts from increased port utilization would increase if a port is used for more than one offshore wind project. Depending upon the specific ports selected to support construction, noise from Alternative A, in combination with the No Action Alternative, would have a variable, temporary, **negligible** to **minor** impact on environmental justice communities.

Noise from onshore construction of Alternative A alone (for the substation and onshore cable route) would be temporary and variable, with **negligible** impacts on environmental justice communities. The Proposed Action's onshore construction activities are not anticipated to overlap in location with other offshore wind projects. If onshore construction activity did overlap with other offshore wind projects adjacent to environmental justice communities, then in the context of reasonably foreseeable environmental trends, the combined onshore noise impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be temporary, variable, and **negligible** to **minor**.

Port utilization, Expansion: Fabrication and staging at the MCT, which is within and surrounded by environmental justice communities (Appendix F), would support offshore construction of Alternative A. The City of New Bedford's Waterfront Framework Plan details goals for expansion, consolidation, and improvement of facilities to support commercial fishing, shipping, and recreational boating along the New Bedford Waterfront, providing for the full range of port users in addition to wind energy (Sasaki et al. 2016). Therefore, use of the MCT and nearby industrial sites to support the Proposed Action would not displace or adversely affect residents or existing businesses. Other industrial and commercial sites with less intense uses, as well as major roads, separate urban residential neighborhoods from the MCT (Sasaki et al. 2016). The New Bedford Waterfront Framework Plan recommends adaptive reuse of brick mill buildings south of the MCT for lower-intensity uses that would buffer the residential neighborhood to the south from the heavy industry of the port.

To support construction of the Proposed Action, Vineyard Wind may also use the port in Providence, which is also in a historic city center within environmental justice communities (Appendix F). The Quonset-Davisville Port is within a developing commerce/industrial park with less extensive nearby economic justice communities. As with the MCT, use of these ports for construction and installation of the Proposed Action would be similar to existing and designated activities at these ports and would not displace businesses in the environmental justice communities or change the nature of land use at the ports.

The Brayton Point and Montaup sites are not adjacent to environmental justice communities (Appendix F). Use of either or both of these sites to support construction of the Proposed Action would not have a disproportionate impact on environmental justice communities.

The Operations and Maintenance Facilities in Vineyard Haven Harbor would contribute positively to employment opportunities and economic activity within or near environmental justice communities (Section 3.6.2) and would have no disproportionate or adverse impacts on low income or minority populations.

No port expansion is proposed in connection with the Proposed Action. The Proposed Action's contributions to increased utilization of the ports of New Bedford, Providence, Quonset-Davisville, and Vineyard Haven may have beneficial impacts on environmental justice communities due to increased employment opportunities and business activity. The local hiring plan described in Appendix D would be part of COP approval and could enhance local hiring, possibly including hiring of low-income or minority residents of the geographic analysis area. The additional requirement described in Appendix D to coordinate with the federally recognized Mashpee Wampanoag Tribe and Wampanoag Tribe of Gay Head (Aquinnah) during implementation of the local hiring plan, when possible and appropriate, could result in increased employment opportunities for members of these tribes. The impacts of Alternative A alone on environmental justice communities from increased port utilization could result from temporary air emissions and noise during construction and would be **negligible**, in addition to the potential beneficial impacts due to new hiring and economic activity for local businesses.

In context of reasonably foreseeable environmental trends, combined port utilization and expansion impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be **negligible to minor** due to air emissions and noise. Port activity would also have beneficial impacts on environmental justice communities, due to increased employment opportunities and business activity. (Beneficial impacts are noted for completeness, but are not part of an environmental justice review under federal guidelines [CEQ 1997]. Therefore, they are not assigned a level of significance.)

Presence of structures: Alternative A's establishment of offshore structures, including up to 100 WTGs, 2 ESPs, and hard cover for cables, would result in both adverse and beneficial impacts on marine businesses (i.e., commercial and for-hire recreational fishing businesses, offshore recreational businesses, and related businesses) and subsistence fishing. Beneficial impacts would be generated by the reef effect of offshore structures, providing additional opportunity for subsistence fishing, tour boats, and for-hire recreational fishing businesses. Impacts would result from navigational complexity within the WDA, disturbance of customary routes and fishing locations, and the presence of scour protection and cable hard cover, leading to possible equipment loss and limiting certain commercial fishing methods. Overall, the offshore structures for Alternative A alone would have minor to moderate impacts on marine businesses (Sections 3.6.2, 3.9.2 and 3.10.2), resulting in long-term, continuous, **minor** impacts on environmental justice populations due to the impact on low-income workers in marine industries and low-income residents and tribal members who rely on subsistence fishing.

Alternative A in combination with other offshore wind energy projects would result in a greater number of offshore structures affecting larger offshore areas. Impacts on marine businesses are anticipated to be minor to major (Sections 3.6.2, 3.9.2, and 3.10.2). This includes major impacts on commercial fishing and supporting businesses; minor to moderate impacts on for-hire recreational fishing; and minor impacts on other marine recreational businesses. Businesses in the commercial fishing sector, associated shore-based businesses, and recreational fishing and boating provide employment for environmental justice populations, although the geographic analysis area's diverse economy also provides employment in other sectors, as described in Section 3.6.1 and 3.6.2. The local hiring plan for Alternative A, described in Appendix D, could reduce the impact on environmental justice populations if it results in job opportunities for low income or minority populations, but it is not anticipated to reduce the overall impact level. In context of reasonably foreseeable environmental trends, the combined impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be long-term, continuous, and **minor**, due to the impact of the offshore wind structures on low-income workers in marine industries and low-income residents and tribal members who rely on subsistence fishing.

As described in Section 3.9.2, portions of all of Alternative A's WTGs could potentially be visible from coastal locations on Martha's Vineyard, Nantucket, and mainland Cape Cod, depending upon vegetation, topography, and atmospheric conditions. Under the 14 MW scenario, nearly all coastal public viewpoints would be more than 15 miles (24.1 kilometers) from the closest WTGs (although additional WTGs could be within 15 miles of other coastal areas not evaluated as distinct viewpoints). Based upon the number of WTGs less than 15 miles from coastal viewing points and available research (Section 3.9), the impact of visible WTGs on recreation and tourism is anticipated to be minor, and the impact is unlikely to meaningfully affect the recreation and tourism industry as a whole. Views of WTGs associated with the Alternative A alone are therefore anticipated to have a **negligible** impact on environmental justice populations based upon the minimal anticipated impact on low-income employees of the recreation and tourism economic sector.

Portions of 775 WTGs from offshore wind development in the RI and MA Lease Areas could potentially be visible from coastal and elevated locations on Martha's Vineyard, Nantucket, and coastal Cape Cod. The views could affect recreation and tourism at a limited number of south-facing locations (Section 3.9.2); however, Section 3.9 anticipates that the Proposed Action, in combination with other offshore wind projects, would have minor impacts on recreation and tourism in the geographic analysis area. In context of reasonably foreseeable environmental trends, combined visual impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be long-term and **negligible**, based upon the potential impact on low-income employees of the recreation and tourism economic sector.

The effects of offshore wind activities on maritime views along the southern coasts of Martha's Vineyard, Nantucket, Cape Cod, and nearby islands would be experienced equally by all populations; however, the visible presence of offshore wind structures would have disproportionate impacts on certain Native American tribes, due to the cultural significance of some ocean views. Visual impacts on certain views with cultural significance to Native American tribes are addressed in detail through the NHPA Section 106 consultation and tribal consultation, as discussed in Section 3.8 and Appendix C.1. The Historic Properties Visual Impact Assessment (VIA) for the Proposed Action determined that the construction of the WTGs would adversely affect the Gay Head Light and the Chappaquiddick Island TCP (COP Volume III, Appendix III-H.b; Epsilon 2020e). Views from the Gay Head Cliffs and Aquinnah Cultural Center (near the Gay Head Light property) and portions of the Chappaquiddick Island TCP have historic and cultural significance for the federally-recognized Wampanoag Tribe of Gay Head (Aquinnah) and the state-recognized Chappaquiddick Wampanoag Tribe, respectively. The Historic Properties VIA 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, Alternative A alone would only affect southern views from these resources. To further minimize and mitigate Alternative A's effects, Vineyard Wind has voluntarily committed to the following measures:

- Avoiding use of the three turbine locations in the northwest corner of the WDA (i.e., those closest to Martha's Vineyard and Nantucket islands);
- Funding a mitigation plan to resolve impacts on the Gay Head Light pursuant to a NHPA Section 106 Memorandum of Agreement;
- 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 WDA (Appendix D); and
- Use of non-reflective pure white (RAL Number 9010) or light grey (RAL Number 7035) paint on offshore infrastructure to minimize daytime visual effects.

The final minimization and mitigation of adverse effects will be determined through completion of BOEM's NHPA Section 106 review process and included as conditions of COP approval, but Section 3.8 concludes that the visual impact on the historic resources would be moderate. Due to the significance of the resources to Native American tribes, the visual impact would have a disproportionate and adverse impact. Accordingly, Alternative A, with the mitigations listed above, would have a long-term, continuous, disproportionately adverse, **moderate** impact on Native American tribes including the federally recognized Wampanoag Tribe of Gay Head (Aquinnah) and the state-recognized Chappaquiddick Wampanoag Tribe. Other future offshore wind projects would result in a greater number of visible WTGs (Section 3.8.2), although visibility would also be limited by distance and influenced by the factors listed above for Alternative A's WTGs. In context of reasonably foreseeable environmental trends, combined visual impacts on Native American tribes, including the federally recognized Wampanoag Tribe of Gay Head (Aquinnah) and the state-recognized Chappaquiddick Wampanoag Tribe, from ongoing and planned actions, including Alternative A, would likely be long-term, continuous, and **moderate**.

Traffic, Vessels: Alternative A would generate vessel traffic within and near the Port of New Bedford and Vineyard Haven Harbor during construction and operations, and may also use the ports of Providence and Quonset-Davisville. Vessel traffic associated with Alternative A construction would have a short-term, minor impact on commercial and for-hire recreational fishing (Section 3.10), due to increased vessel traffic near ports and at the WDA. Based on the minor impacts on commercial and for-hire recreational fishing, the construction and decommissioning of Alternative A alone would have a short-term, **negligible** impact on low-income residents or tribal members involved in the commercial fishing industry or subsistence fishing. Vessel traffic would be limited during operations and would have a long-term, **negligible** impact on environmental justice communities.

Section 2.3 describes the non-routine activities associated with the Proposed Action. Spills from maintenance or repair vessels or activities requiring repair of WTGs, equipment, or cables, would generally require intense, temporary activity associated with oil spill response (COP Volume I, Appendix I-A; Epsilon 2020a) or to address emergency conditions. The presence of unexpectedly frequent vessel activity in Vineyard Haven Harbor or New Bedford Harbor, and in offshore locations above the OECC or near individual WTGs, could temporarily prevent or deter subsistence or commercial fishing or for-hire recreational fishing, or tourist activities near the site of a given non-routine event. The impacts of non-routine activities resulting from Alternative A alone on environmental justice populations would be **minor**.

Vessel traffic would increase if multiple offshore wind projects use the same ports during overlapping construction periods, and is projected to have a minor to moderate impact on commercial and for-hire fishing. In context of reasonably foreseeable environmental trends, combined vessel traffic impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be short-term and **minor** during construction and decommissioning, due to the potential impacts of increased vessel traffic near ports on subsistence fishing and low-income employees of the commercial/for-hire fishing industry, and **negligible** during operations.

Vessel traffic from the Proposed Action, and from the Proposed Action in combination with the No Action Alternative, would also have beneficial impacts on environmental justice communities through increased employment and economic activity for marine transportation and supporting businesses.

Land disturbance: As shown in Appendix F, the Alternative A substation is in an area that meets the criteria for both low-income and minority status. A majority of the route for the Covell's Beach landfall site would pass through or adjacent to communities that meet low-income and/or minority environmental justice criteria. Construction of the OECR would temporarily disturb neighboring land uses through construction noise, vibration and dust, and delays in travel along the impacted roads. Environmental justice and non-environmental justice communities would equally experience these impacts, and access to neighborhoods would be maintained. Accordingly, land disturbance from the onshore construction of Alternative A alone, including the cable route from the Covell's Beach landfall, would have temporary, **negligible** impacts on environmental justice communities.

Alternative A's onshore land disturbance activities are not anticipated to overlap in location with other offshore wind projects. If land disturbance overlaps with other offshore wind projects, in context of reasonably foreseeable environmental trends, the combined onshore land disturbance impacts on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be temporary, variable, and **negligible** to **minor**.

During operation, the onshore transmission cable infrastructure, including cable landfall sites and onshore cables, would be underground and primarily within roads and utility ROWs, while the substation would operate within an industrial area. As a result, operations and occasional maintenance or repair operations from Alternative A alone would have **negligible** impacts based upon the "land use changes" sub-IPF, and would not result in disproportionate impacts on environmental justice communities. Underground transmission cables and substations for other offshore wind development are anticipated to use cable routes and substation locations that comply with local land use regulations and these improvements are not likely to be close enough to the Proposed Action to impact the same neighboring land uses. Accordingly, in context of reasonably foreseeable environmental trends, combined impacts of land use changes on environmental justice populations from ongoing and planned actions, including Alternative A, would likely be **negligible**.

In summary, BOEM anticipates that Alternative A alone would have **negligible to major** impacts on environmental justice populations within the study area based upon all IPFs, including certain disproportionately adverse impacts on Native American tribes. During installation of the onshore cables and substation, the IPFs associated with Alternative A alone would result in **negligible** impacts on environmental justice communities due to air emissions and noise at ports and onshore construction sites. During both construction and operations, the impacts on low-income employees of marine industries and supporting businesses (commercial fishing, support industries, marine recreation, and tourism) from all IPFs would range from **negligible** to **minor.** The **minor** impacts would result from disruption of marine activities during offshore cable installation and the impacts on commercial and for-hire fishing resulting from the long-term presence of offshore structures. Damage to submerged landforms resulting from offshore construction would result in **major** disproportionate impacts on Native American tribes that trace their ancestry to these landforms. Coastal views of offshore structures would have impacts on cultural resources important to the federally recognized Wampanoag Tribe of Gay Head (Aquinnah) and the state-recognized Chappaquiddick Wampanoag Tribe, with **moderate** impacts on these tribes. Considering the combined impacts of all IPFs, BOEM anticipates that Alternative A would have overall **minor** impacts on all environmental justice populations. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.7.1.2.

In context of reasonably foreseeable environmental trends, the combined impacts of all IPFs on environmental justice populations from ongoing and planned actions, including Alternative A, would range from **negligible** to **major**, including some disproportionately adverse impacts on Native American tribes. Impacts on environmental justice communities near ports and onshore construction areas due to air emissions and noise would be **negligible to minor**. Impacts on low income employees of marine industries and supporting businesses (commercial fishing, support industries, marine recreation and tourism) would be **minor**, based upon the anticipated temporary disruption of marine activities due to offshore cable installation and construction noise, and increased vessel traffic during construction, as well as long-term impacts on the marine-dependent businesses resulting from the long-term presence of offshore structures. Impacts on cultural resources significant to Native American tribes would include disproportionately adverse, **moderate** impacts on culturally important ocean views and **major** impacts resulting from damage to submerged landforms during cable emplacement. Potentially beneficial impacts on environmental justice populations would result from port utilization and increased vessel traffic, and the resulting employment and economic activity. Beneficial impacts could also result if wind energy displaces fossil fuel energy generation in locations that improve air quality and health outcomes for environmental justice populations.

Considering all the IPFs together, BOEM anticipates that the combined impacts on environmental justice populations from ongoing and planned actions, in context of reasonably foreseeable environmental trends, would be **moderate** overall. The main drivers for the impact ratings are the long-term, **minor** impacts associated with the presence of offshore structures, as discussed in Section 3.7.2, which affect marine-dependent businesses (commercial fishing, for-hire recreational fishing, boat tours and other marine recreational businesses) that may hire low-income workers, the **major**, disproportionate impacts on Native American tribes from damage to submerged landforms, and the **moderate** visual impacts on culturally significant locations. Alternative A would contribute to the overall impact rating primarily through the same IPFs. The overall impact rating is also supported by anticipated **negligible** to **minor** impacts from air emissions and noise, **minor** impacts from offshore construction-related noise and cable emplacement, and construction-related vessel traffic, which would be short term and variable. The overall rating also reflects the **major**, disproportionate impact on Native American tribes due to impacts on submerged landforms, as well as ongoing efforts to develop a treatment plan to address those impacts (Section 3.8).

3.7.3. Consequences of Alternatives C, D1, D2, and E

The impacts of Alternatives C, D1, D2, and E on environmental justice populations are summarized below:

- Alternative C would relocate six WTGs from the northern to the southern portion of the WDA, thus providing more unobstructed space for navigation in the northern WDA and reducing visual impacts on culturally significant land areas and recreation areas. As noted in Sections 3.9 and 3.10, the overall level of impact on recreation and tourism and commercial fishing (respectively), and the related employment opportunities, would not change; therefore, the impacts of Alternative C on environmental justice populations would be the same as those of Alternative A.
- Alternatives D1 and D2 would result in different WTG configurations, each of which would marginally increase navigation flexibility, but would not change the overall environmental justice impacts of the proposed Project. As noted in Section 3.11, Alternatives D1 and D2 would have both beneficial impacts (increased spacing between WTGs, improved maritime navigation) and adverse impacts (increased WDA size), depending on fishery and activity, with no change to the overall impact level. Therefore, the impacts of these alternatives on low-income workers in commercial fishing and supporting industries would be similar to those of Alternative A.
- Alternative E would include up to 84 WTGs using a combination of 9 to 10 MW WTGs, compared to 100, 8 MW WTGs for Alternative A (in the maximum-case scenario), with potential increases in the spacing of WTGs and improved access to fishing locations. No change in the overall impact level on visual impacts on cultural resources (Section 3.8), or on commercial and for-hire recreational fishing is anticipated (Section 3.10). Other environmental justice impacts of Alternative E would be the same as Alternative A.

Accordingly, the impacts resulting from individual IPFs associated with Alternatives C, D1, D2, and E on environmental justice communities would be the same as those of Alternative A: **negligible** to **major** impacts, due to the IPFs discussed above, along with beneficial impacts due to new hiring and economic activity.

In context of reasonably foreseeable environmental trends, combined impacts from individual IPFs from ongoing and planned actions, including Alternatives C, D1, D2, and E, would be **negligible** to **major**, because the majority of the impacts of any alternative come from other offshore wind projects, and the impacts of each alternative would be very similar to those of Alternative A.

In context of reasonably foreseeable environmental trends, combined overall impacts on environmental justice populations from ongoing and planned actions, including Alternatives C, D1, D2, and E, would be **moderate**. The impact rating is primarily driven by potential impacts on submerged landforms, visual resources, subsistence fishing and shellfishing, low-income workers in marine industries from the long-term presence of offshore structures and short-term cable emplacement, and vessel traffic.

3.7.4. Consequences of Alternative F

The impacts of Alternative F on environmental justice populations would be substantially the same as Alternative A, based upon the conclusion in Section 3.6.4 that although the revised layout would reduce impacts on marine businesses from two sub-IPFs related to the presence of offshore structures, most IPFs and the overall impact rating would not change. Impacts would vary based on the underlying layout:

- The combination of Alternative F and Alternative A would reduce impacts from IPFs related to the risk of allisions and collisions and the visibility of WTG structures and hazard lighting; and
- The combination of Alternative F and Alternative D2 would increase impacts related to risk of allisions and collisions and would reduce impacts from the visibility of WTG structures and hazard lighting.

The differences would not be significant enough to change the impact levels, and the impacts of Alternative F alone on environmental justice populations, resulting from individual IPFs, would remain **negligible** to **major**. Based on BOEM's analysis this would be true regardless of the width of the transit lane.

In context of reasonably foreseeable environmental trends, combined impacts on environmental justice from ongoing and planned actions, including Alternative F, would be very similar to those of Alternative A, with **negligible** to **major** impacts on environmental justice populations along with beneficial impacts due to new hiring and economic activity. The majority of the impacts of any alternative come from other offshore wind projects, and the impacts of this alternative would be very similar to those of Alternative A. The overall impacts of Alternative F on environmental justice populations, in the context of reasonably foreseeable environmental trends and planned actions, would be **moderate**. The impact rating is primarily driven by impacts on submerged landforms, visual resources, subsistence fishing and shellfishing, low-income workers in marine industries from the long-term presence of offshore structures and short-term cable emplacement, and vessel traffic.

BOEM has qualitatively evaluated the impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. To the extent additional transit lanes are implemented in the future outside the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located farther from shore, similar to the proposed Project under Alternative F. As a result, establishment of these additional transit lanes could require longer vessel trips for all phases of future projects and longer timeframes for cable installation. Collectively, these effects would result in greater impacts on environmental justice populations overall than if Alternative F were not implemented, due to increased impact on marine businesses (as discussed in Section 3.6.4) that employ low-income residents in the analysis area.

In addition to longer vessel transits and cable routes, if all transit lanes suggested by RODA were implemented, the technical capacity of offshore wind power generation in the RI and MA Lease Areas would not be met (Section 2.1.4). As noted in Section 3.7.1.1, power generated by offshore wind could potentially benefit minority and low-income populations if it leads to lower regional air emissions from fossil fuel power generation. Thus, a reduced capacity for wind power generation could reduce the potential benefit to minority and low-income populations of reduced exposure to air pollutants and resulting health benefits.

3.7.5. Comparison of Alternatives

As discussed above, the impacts associated with Alternative A alone do not change substantially under Alternatives C through F. The alternatives are very similar in terms of the impacts on environmental justice communities and populations, except that Alternative F, in combination with Alternative A, would result in an incrementally smaller impact on commercial fishing and marine recreation businesses due to reduced navigational impacts related to offshore structures. The difference in Alternative F would not change the overall impact magnitudes, compared to those of Alternative A. Net reductions in emissions resulting from offshore wind development would result in long-term, regional air quality benefits, with resulting health benefits, by displacing emissions from fossil fuel-generated power plants. The reduced air pollutants and health benefits associated with offshore wind development would be the same across all Alternatives except F, which could potentially result in diminished offshore wind capacity with resulting reduced air quality benefits for minority and low-income populations.

Impacts under Alternative A or any action alternative would likely be very similar because the majority of the impacts of any alternative come from other future offshore wind development, which does not change between alternatives, and the differences in impacts between action alternatives would not result in different impact magnitudes. Therefore, in the context of reasonably foreseeable environmental trends, the overall impact of any action alternative when combined with planned actions would be similar. See Table 2.4-1 for a comparison of alternative impacts.

3.7.6. Summary of Impacts of the Preferred Alternative

The Preferred Alternative would be a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. The Preferred Alternative would include the local hiring plan, use of ADLS, and approved WTG paint color. The Preferred Alternative would relocate the six northernmost WTG to the southern portion of the lease area as well as use between 57 to 84 WTGS which would have 1 nautical mile by 1 nautical mile spacing in an east-west orientation. This change would incrementally reduce the economic and cultural effects resulting from visual impacts of Alternative A alone, and would shift the location of some WTG and cable installation activities. In all other aspects, construction and operation of the Preferred Alternative would be similar to Alternative A. Accordingly, construction of the Preferred Alternative alone would remain of the same level as for Alternative A (**minor**).

3.8. CULTURAL RESOURCES

3.8.1. No Action Alternative and Affected Environment

This section discusses baseline conditions in the geographic analysis area for cultural resources as described in Table A-1 and shown on Figure A.7-8 in Appendix A. 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 future offshore wind projects would be visible simultaneously. Table 3.8-1 describes baseline conditions and the impacts, based on the IPFs assessed for ongoing and future offshore activities other than offshore wind, which is discussed below.

Cultural resources refers to many heritage-related resources defined in federal laws and EOs, including NEPA and the NHPA. For the purpose of this analysis, cultural resources have been divided into three principal types: archaeological resources, historic structures, and TCPs. Archaeological resources comprise areas where human activity has altered the earth and/or deposits of physical remains of past human activity (e.g., artifacts) are found. Historic structures include standing buildings, bridges, dams, and other structures of historic or aesthetic significance. TCPs are places, landscape features, or locations associated with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. Resources with historic significance and integrity under NHPA criteria are called "historic properties," and are eligible for or listed in the NRHP. Generally, historic properties must be more than 50 years old to warrant consideration for the NRHP. Historic properties less than 50 years old might warrant protection if they are of exceptional importance or have the potential to gain significance in the future.

Table 3.8-2 presents a summary of the pre-Contact period and post-Contact period cultural context of southern New England (Epsilon 2019c).[19] The proposed geographic analysis area for cultural resources is equivalent to the Project's area of potential effect (APE), as defined in the implementing regulations for NHPA Section 106 at 36 C.F.R. Part 800 (Protection of Historic Properties). In 36 C.F.R. § 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."[20] BOEM (2018a) defines the Project APE as the following:

- The depth and breadth of the seabed potentially impacted by any bottom-disturbing activities, constituting the marine archaeological resources portion of the APE;

[19] In this context, "Contact" refers to the arrival of Europeans in southern New England circa 1620.

[20] 36 C.F.R. Part 800 defines effects to historic properties in terms of direct and indirect effects. For the purposes of this analysis, both physical impacts or effects and visual impacts or effects to historic properties are considered direct effects as defined in the NHPA and its implementing regulations (36 C.F.R. Part 800).

- The depth and breadth of terrestrial areas potentially impacted 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.

Vineyard 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.

The No Action Alternative assumes the full build out of all reasonably foreseeable wind projects. BOEM assumes that each of the reasonably foreseeable 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.[21] 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, and/or mitigate effects in order to comply with the NHPA.

Onshore cultural resource investigations in the northeastern United States have identified a wide variety of archaeological resources, historic structures, and TCPs that could be adversely affected by development projects, including future offshore wind. Previously identified archaeological resources include terrestrial pre-Contact Period Native American sites and 17th through 20th century European-American sites. Historic standing structures found across the northeastern United States include a wide variety of residential, commercial, and industrial buildings, structures, and infrastructure that date from the 17th through 20th centuries. Potential TCPs in the northeastern United States include a variety of locations associated with the cultural practices, traditions, beliefs, lifeways, arts, crafts, and/or social institutions of Native Americans, European-Americans, and other living communities across the region.

Offshore cultural resources in the northeastern United States 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 31 submerged landform features with the potential to contain Native American archaeological resources within the Proposed Action WDA and OECC; all of the proposed offshore wind lease areas are in areas with high probability for containing these submerged landform features (TRC 2012). In addition to their archaeological potential, Native American tribes in the region consider remnant submerged landscape features to be TCP resources representing places where their ancestors lived. Historic period European-American marine cultural resources consist of shipwrecks, downed aircraft, and related debris fields dating to the 16th through 20th centuries. Marine geophysical remote sensing studies performed for the Proposed Action identified two shipwrecks and five debris fields within the WDA and OECC. Based on known historic and modern maritime activity in the region, all of the proposed offshore wind lease areas are in areas with a high probability for containing shipwrecks, downed aircraft, and related debris fields.

[21] The NEPA geographic analysis area for each offshore project includes areas impacted by reasonably foreseeable offshore wind projects, whereas the NHPA APE for each project is limited to the areas within which each project may adversely affect historic properties.

3.8.1.1. Future Offshore Wind Activities (without Proposed Action)

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

Accidental releases: Accidental release of hazmat and trash/debris, if any, may pose a 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 expanded impact analysis scenario, there would be a low risk of a leak of fuel, fluids, or hazmat from any of the approximately 775 WTGs and 20 ESPs. Each WTG would store approximately 5,049 gallons (19,113 liters) of such fluids, while each ESP would store approximately 129,301 gallons (489,458 liters). In total, approximately 5.3 million gallons (20 million liters) would be stored within the geographic analysis area for cultural resources. By comparison, the smallest tanker vessel operating in these waters (a general-purpose tanker) has a capacity of between 3.2 and 8 million gallons (12.1 million to 30.3 million liters). As described in Section A.8.2, tankers are relatively common in these waters; therefore, the total storage capacity within the geographic analysis area is considerably less than the volumes of hazardous liquids being transported by ongoing activities (U.S. Energy Information Administration 2014). The number of accidental releases from the No Action Alternative, the volume of released material, and the associated need for cleanup activities would be limited due to the low probability of occurrence, the low volumes of material released in individual incidents, the low persistence time, standard BMPs to prevent releases, and the localized nature of such events. As such, the majority of individual accidental releases from future offshore wind development would not be expected to result in measurable impacts on cultural resources.

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 the complete removal of coastal and marine cultural resources during the removal of contaminated terrestrial soil or marine sediment; environmental impacts could result in temporary or permanent impacts on the setting of coastal historic standing structures; and nearshore shipwreck or debris field resources could be damaged or removed 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, accelerating their decomposition and/or covering them and making them inaccessible/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 impacts on cultural resources.

Anchoring, gear utilization, and dredging: Anchoring, gear utilization, and dredging activities associated with ongoing commercial and recreational activities and the development of future offshore wind projects have the potential to cause permanent, adverse impacts on marine cultural resources. Anchoring, gear utilization, and dredging activities would increase during the construction, maintenance, and eventual decommissioning of future offshore wind energy facilities. The expanded planned action scenario could result in up to 126 acres (0.5 km^2) of seafloor in the geographic analysis area for cultural resources affected by anchoring. The placement and relocation of anchors and other seafloor gear such as wire ropes, cables, and anchor chains that impact or sweep the seafloor could potentially disturb shipwreck and debris field resources on or just below the seafloor surface. Dredging activities could similarly affect marine cultural resources. 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.

The scale of impacts on shipwreck and debris field cultural resources would depend on the number of wreck and debris field sites within the proposed wind project development 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, and/or mitigate impacts on these resources. As a result, impacts on marine cultural resources from anchoring, gear utilization, and dredging 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.

Light: Development of future offshore wind projects would increase the amount of offshore anthropogenic light from vessels, area lighting during the construction and decommissioning of projects (to the degree that construction occurs at night), and the use of aircraft and vessel hazard/warning lighting on WTGs and ESPs during operation. Up to 795 foundations (775 WTGs and 20 ESPs) would be added within the geographic analysis area for cultural resources, assuming WTGs with a maximum blade tip height of 853 feet (260 meters) AMSL.

Construction and decommissioning lighting would be most noticeable if construction activities occur at night. As shown in Table A-4 in Appendix A, up to 12 lease areas could be constructed from 2022 through 2030 (with up to four projects simultaneously under construction in 2024; Table A-6). Some of the future 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 ESP sites rather than the entire RI and MA Lease Areas. Aircraft and vessel hazard lighting systems would be in use for the entire operations phase of each future offshore wind project, resulting in long duration impacts. The intensity of these impacts would be relatively low, as the lighting would consist of small intermittent flashing lights at a significant distance from the resources.

The impacts of construction and operations lighting would be limited to cultural resources on the southern shores of Martha's Vineyard, Nantucket, and possibly portions of Cape Cod, for which a dark nighttime sky is a contributing element to historical integrity. This excludes resources that are closed to stakeholders at night, such as historic buildings, lighthouses, and battlefields and resources that generate their own nighttime light, such as historic districts. 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 are located over 15 miles (24.1 kilometers) from the nearest shoreline (Section 3.9). 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 ESPs only when an aircraft is within a predefined distance of the structures (detailed explanation in Section 3.6). For the Proposed Action, this is estimated to occur during less than 0.1 percent of total annual nighttime hours (Section 3.9). The use of ADLS lighting on future offshore wind projects other than the Proposed Action would likely result in similar limits on the frequency of WTG and ESPs aviation warning lighting use. This technology, if used, would reduce the already low-level impacts of lighting on cultural resources.

Port utilization: Expansion: Expected increases in port activity associated with the development of future offshore wind projects would likely require port modifications and expansions at ports along the U.S. East Coast. The MassCEC identified 18 waterfront sites in Massachusetts that could be available and suitable for use by the offshore wind industry (MassCEC 2017a, b). Orsted has committed to improvements to Rhode Island ports in support of the Revolution Wind Project (Kuffner 2018). These port modification and expansion projects could affect historic structures and/or 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 ESPs components and/or increased vessel traffic associated with future 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, and/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.

Presence of structures: The development of future offshore wind projects would introduce new, modern, and intrusive visual elements to the viewsheds of cultural resources along the southern coasts of Rhode Island and Massachusetts, including Martha's Vineyard, Nantucket, and adjacent islands. In the expanded planned action scenario, up to 795 foundations (775 WTGs and 20 ESPs) would be added within the geographic analysis area for cultural resources, assuming WTGs with a maximum blade tip height of 853 feet (260 meters) AMSL.

Impacts on cultural resources from the presence of structures would be limited to those cultural resources from which future offshore wind projects would be visible, which would typically be limited to historic standing structures 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 NRHP. Due to the distance between the reasonably foreseeable wind development and the nearest cultural resources, in most instances exceeding 15 miles (24.1 kilometers), WTGs within 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. Additional mitigations, such as the use of non-reflective off-white and light grey paint on offshore structures, could reduce the visibility of offshore structures and further reduce the magnitude of visual impacts on cultural resources.

New cable emplacement/maintenance: Construction of future offshore wind infrastructure would have permanent, geographically extensive, adverse impacts on cultural resources. Future offshore wind projects would result in the construction of 795 foundations for WTGs and ESPs and 3,400 acres (13.7 km^2) of seabed disturbance from installation of inter-array and offshore export cables. Given the locations of RI and MA Lease Areas and the COPs or other announced plans for offshore export cable routes, the only future offshore wind activities (other than the Proposed Action) that may be expected to lay cable in the geographic analysis area are Vineyard Wind 2 (OCS-A 0501 [southern portion]), Mayflower Wind (OCS-A 0521), Equinor Wind US (OCS-A 0520), and Bay State Wind (OCS-A 0500). Of these, only Vineyard Wind 2 and Mayflower Wind have announced plans for cable routes in the geographic analysis area for cultural resources. Vineyard Wind 2 would lay cable within the same OECC as the Proposed Action, and Mayflower Wind would lay cable somewhere between Martha's Vineyard and Muskeget Island, through Nantucket Sound, making landfall somewhere on Cape Cod. Because precise cable corridors are not known for any specific project other than Vineyard Wind 2, the potential impacts of future offshore wind activities (other than the Proposed Action) on cultural resources are not reasonably quantifiable. The 2012 BOEM study and the Proposed Action studies (Epsilon 2019b; TRC 2012; Vineyard Wind 2019a) suggest that the WDAs and OECCs of the future offshore wind projects would likely contain a number of archaeological sites and submerged landform features, which could be impacted by offshore construction activities.

As part of compliance with the NHPA, BOEM and state historic preservation offices will require future offshore wind project applicants to conduct extensive geophysical surveys of WDA and OECC areas to identify shipwreck and debris field resources, and avoid, minimize, and/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.

Formerly sub-aerially exposed and now submerged landscapes that date to a time of Native American inhabitation are considered potentially significant resources due to their potential to contain archaeological sites, as well as their significance to regional Native American tribes. Regional Native American tribes may consider extant submerged landform features to be part of a larger cultural landscape occupied by their ancestors. As a result, the submerged landform features are considered part of one or more TCPs due to their association with the cultural practices, traditions, and beliefs of Native American tribes.

If present within a project area, the number, extent, and dispersed character of 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 submerged landform features that are contributing elements to a National Register-eligible TCP, but which cannot be avoided, mitigations will likely be considered under the NHPA Section 106 review process, including studies to document the nature of the paleo 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.

Land disturbance: The construction of onshore components associated with future 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 impacted, the scale and extent of impacts, and the 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 impacted. State and federal requirements to identify cultural resources, assess project impacts, and develop treatment plans to avoid, minimize, and/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.

Climate change: IPFs related to climate change, including 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/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/corrosion of shipwreck, downed aircraft, and other marine archaeological resources on the seafloor. The incremental contribution of future offshore wind energy projects on slowing or arresting global warming and climate change related impacts would result in beneficial impacts on cultural resources.

3.8.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, the proposed Project would not be built. However, cultural resources would continue to be affected by regional commercial, industrial, and recreational activities including future offshore wind projects.

While the proposed Project would not be built under the No Action Alternative, BOEM expects ongoing activities, reasonably foreseeable activities other than offshore wind, and future offshore wind activities to have continuing short- and long-term impacts on cultural resources. The primary source of onshore impacts from ongoing activities include ground-disturbing activities and the introduction of intrusive visual elements, while the primary source of offshore impacts include dredging, cable emplacement, and activities that disturb the sea floor. These ongoing activities would have **minor** to **major** impacts on individual onshore and offshore cultural resources.

Reasonably foreseeable activities other than offshore wind could include the same type of onshore and offshore actions listed for ongoing activities, and in different locations than ongoing activities. These reasonably foreseeable actions 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. Examples of individual resources are paleolandforms, terrestrial archaeological sites, historic standing structures, and TCPs. Impacts vary widely because the impacts are dependent on the unique characteristics of the individual resources. BOEM expects the combination of ongoing and reasonably foreseeable activities to result in **minor** to **major** impacts on individual cultural resources depending on the scale and extent of impacts and the unique characteristics of the resources. Impacts vary widely because the impacts are dependent on the unique characteristic of the individual resource.

The construction, operation, and maintenance of reasonably foreseeable offshore wind projects would have **minor** to **major** effects as well as **negligible** to **minor** beneficial impacts on individual offshore cultural resources. The construction and installation of onshore components and port expansion, as well as their operation and maintenance, would have **negligible** to **minor** impacts on individual cultural resources.

Considering all the IPFs together, both negative and beneficial, as well as state and federal requirements to avoid, minimize, or mitigate impacts to cultural resources, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area combined with ongoing activities and reasonably foreseeable activities other than offshore wind would result in **moderate** adverse impacts to 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 is largely dependent on the unique characteristics of individual cultural resources, resulting in a range of potential impacts from **minor** to **major**.

While impacts to cultural resources could range from **minor** to **major**, BOEM anticipates that implementation of existing state and federal cultural resource laws and regulations would reduce the magnitude of overall impacts on cultural resources due to requirements to avoid, minimize, or mitigate Project-specific impacts on cultural resources. These state and federal requirements may not be able 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 to cultural resources.

3.8.2. Consequences of Alternative A

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on cultural resources:

- Physical impacts on terrestrial cultural resources (e.g., archaeological sites) would depend on the location of onshore ground disturbing activities.
- Physical impacts on underwater cultural resources (e.g., archaeological sites and submerged landscapes) would depend on the location of offshore bottom-disturbing activities. This includes the locations where Vineyard Wind would embed the WTG and ESP towers into the seafloor in the WDA and the location of the cable in the OECC.
- Visual impacts on cultural resources (e.g., historic architectural structures, landscapes, and traditional cultural properties) would depend on the design, height, number, and distance of WTGs visible from these resources.

If Vineyard Wind were to install 57, 14 MW WTGs instead of the potential 100, 8 MW WTGs initially evaluated, the overall height of the 14 MW WTGs (a hub height of 473 feet AMSL and a maximum blade tip height of 837 feet [255 meters] AMSL) would increase the number and portion of WTGs visible from affected resources, but could decrease the number of submerged cultural resources impacted, due to the reduction in number of WTGs. Because of the increased visibility of the 14 MW WTGs, this section evaluates the impacts on cultural resources of Alternative A with the 14 MW WTG option. With incorporation of these design changes into the analysis, Alternative A would have **negligible** to **minor** impacts on most cultural resources, but would have **moderate** impacts on the Gay Head Light, the Chappaquiddick Island TCP, the Nantucket Island National Historic Landmark (NHL), the Vineyard Sound and Moshup's Bridge TCP, and submerged landform features within the WDA and the OECC.

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, and submerged landforms) from offshore bottom-disturbing activities, resulting in a loss of scientific and/or cultural value. Potential impacts also include demolition of, damage to, or alteration of historic structures or districts, resulting in a loss of historic and/or cultural value. Potential visual impacts also include introduction of visual elements out of character with the setting or feeling of historic structures, landscapes, and TCPs, if that setting is a contributing element to the resource's eligibility for listing on the NRHP. The most impactful IPFs would include light, presence of structures, and offshore construction.

Accidental releases: Accidental release of hazmat and trash/debris, if any, could affect cultural resources. The 59 WTG and ESP foundations for Alternative A alone would include storage for up to 24,157 gallons (93,715 liters) of coolants, 341,869 gallons (1.3 million liters) of oils and lubricants, and 50,897 gallons (192,666 liters) of diesel fuel. The volume of materials release is unlikely to require cleanup operations that would permanently impact cultural resources. As a result, the impacts of accidental releases from Alternative A alone on cultural resources would be short-term, localized, and **negligible**. Impacts from future offshore wind projects would be similar to those of Alternative A, but could occur throughout the RI and MA Lease Areas. In the context of reasonably foreseeable trends, the combined impacts of accidental releases from ongoing and planned actions, including Alternative A, would be a low risk of a leak of fuel, fluids, or hazmat from any of the approximately 775 WTGs and 20 ESPs, which would include storage for up to 5.3 million gallons (20 million liters) of these substances. The overall impacts on cultural resources from accidental releases from Alternative A when combined with ongoing and planned actions would have short-term, localized, and **minor** impacts on cultural resources.

Anchoring, gear utilization, and dredging: Vineyard Wind conducted high-resolution geophysical surveys and marine archaeological resource assessment of the WDA and OECC over three survey seasons in 2016, 2017, and

2018. Field investigations during all three surveys included a marine HRG survey utilizing magnetometer, side-scan sonar, sub-bottom profiler, and multibeam echosounder. Geotechnical explorations included bottom grabs, Cone Penetration Tests, bores, and/or vibracores conducted in the WDA and along the OECC. These data assisted in validating the geophysical data and interpretations and provided material for additional archaeological analysis (COP, Volume II-C; Epsilon 2019c). The HRG and geotechnical surveys identified two shipwrecks and five potential shipwrecks/debris fields. The Proposed Action has committed to avoiding these resources during construction, maintenance, and decommissioning activities. Due to these commitments, BOEM does not anticipate impacts on known shipwreck and debris field sites from development of Alternative A. As a result, anchoring, gear utilization, and dredging associated with Alternative A alone (4 acres [0.02 km^2]) would have **negligible** impacts on marine cultural resources, although larger impacts could occur if a previously undiscovered resource is affected.

Additional studies conducted in 2019 concluded that the Project would be unable to avoid 19 submerged landforms due to design constraints (i.e., the submerged landform crosses the entire OECC), engineering, and/or environmental constraints (Epsilon 2019c). As currently designed, construction of Alternative A would result in physical effects on the 19 ancient landforms that cannot be avoided (Epsilon 2019c). Physical effects on these resources would threaten the viability of the affected portion of these resources as both potential repositories of archaeological information, as well as the cultural significance of these landforms to local Native American tribes. The severity of effects would depend on the horizontal and vertical extent of effects relative to the size of the intact submerged relict landform. Due to the limited size of the offshore remote sensing survey areas in the OECC and WDA, the full extent or size of individual ancient landforms cannot be defined. Based on available information, construction of Alternative At would result in the physical damage or destruction of all or part of the 19 ancient landforms that cannot be avoided. As a result, anchoring, gear utilization, and dredging associated with Alternative A (4 acres [0.02 km^2]) would have **major** impacts on submerged landform features.

In the expanded planned action scenario, there could be up to 126 acres (0.5 km^2) of anchoring occurring within the geographic analysis area that could potentially affect cultural resources. BOEM anticipates that lead federal agencies and relevant state historic preservation offices would require the applicants for future 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 submerged landform features as part of NEPA and NHPA Section 106 compliance activities. BOEM would also continue to require developers to avoid, minimize, or mitigate impacts on any identified marine archaeological resources and submerged landform features during construction, operation, and decommissioning. As a result, in context of reasonably foreseeable trends, combined anchoring, gear utilization, and dredging impacts from ongoing and planned actions, including Alternative A, on shipwreck and debris field resources, as well as submerged landforms, would be long-term, localized, and **moderate** to **major**, unless previously undiscovered resources are affected.

Light: As previously discussed, development of the offshore wind industry would increase the amount of offshore anthropogenic light from vessels, area lighting during the construction and decommissioning of projects (to the degree that construction occurs at night), and the use of hazard/warning lighting on WTGs and ESPs during operations. The susceptibility and sensitivity of cultural resources to lighting impacts from Alternative A 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, cultural resources stakeholders use at night, and resources that do not generate a substantial amount of their own light pollution. Examples of these types of resources in the geographic analysis area of this study include the Chappaquiddick Island, Vineyard Sound and Moshup's Bridge, and Nantucket Sound TCPs.

Construction of Alternative A 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 Alternative A. The intensity of nighttime construction lighting from Alternative A 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 Martha's Vineyard and Nantucket. The intensity of nighttime construction lighting would also decrease significantly during the construction of WTGs and ESPs further and further from shore as distance from the lighting source and resources increased. 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 and/or resources used by stakeholders at night, limiting the scale of impacts on cultural resources. As a result, nighttime vessel and construction area lighting from Alternative A alone would have short-term, low intensity impacts on a limited number of resources, resulting in **minor** impacts on cultural resources.

As previously discussed, up to 12 different lease areas could be constructed from 2022 through 2030 (with up to five projects simultaneously under construction in 2024), and some future offshore wind projects could require nighttime construction lighting. Construction lighting from any project would be temporary, lasting only during nighttime construction, and could be visible from shorelines and elevated locations. Sources of light would be limited to individual WTG or ESP sites under construction rather than the entire RI and MA Lease Areas. Although the nighttime lighting impacts from individual projects would be short-term and the distance and the number of WTGs and/or ESPs under construction would limit the intensity of individual nighttime construction impacts, construction of the 12 different lease areas would result in nighttime lighting impacts for 9 years with the potential for multiple projects being simultaneously under construction. Similar to Alternative A alone, these impacts would be restricted to a limited number of cultural resources, and the intensity of impacts would decrease with distance from the shoreline and 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 associated with Alternative A alone would have long-term, low intensity impacts on a limited number of resources, resulting in **minor** impacts on cultural resources.

Cultural resources would also be susceptible to nighttime and daytime lighting impacts from operations phase aviation and vessel hazard avoidance lighting on WTGs and ESPs. The use of standard aviation warning lights on Alternative A WTGs would result in long-term, continuous, **moderate** impacts on the cultural resources. Vineyard Wind has committed to voluntarily implementing ADLS to reduce operation phase nighttime lighting impacts. ADLS would only activate the required FAA aviation obstruction lights on WTGs and ESPs when aircraft enter a predefined airspace and turn off when the aircraft were to no longer be in proximity to the WDA (COP Volume III, Appendix III-N; Epsilon 2020b). For Alternative A, this was estimated to occur 235 times during the year, illuminating less than 0.1 percent of nighttime hours per year (Section 3.9). More specifically, in accordance with FAA Advisory Circular 70/7460-1L (FAA 2015), lights controlled by an ADLS must be activated and illuminated prior to an aircraft reaching 3 nautical miles (5.6 kilometers) from within 1,000 vertical feet (305 meters) of any wind turbine. Due the speed of the traveling aircraft and size of the WDA, the resulting appearance of the lights would be limited to a few minutes in each instance. For the proposed Project, this was estimated to occur 235 times per year, for a total of less than 4 hours per year (less than 0.1 percent of annual nighttime hours) (COP Volume III, Appendix III-N; Epsilon 2020b). As a result, the use of ADLS by Alternative A would result in intermittent, low intensity (rather than continuous), **minor** impacts on cultural resources.

USCG navigation warning lights would be mounted near the top of the foundation on each WTG and ESP. The lighting is relatively low intensity, and would be visible up to 5 nautical miles (COP Volume III, Appendix III-H.b; Epsilon 2020e). This lighting could be visible to mariners at sea, but would not be visible from coastal vantage points.

Up to 775 WTGs and 20 ESPs would be added by the development of future offshore wind projects within the geographic analysis area for cultural resources (assuming WTGs with a maximum blade tip height of 853 feet [260 meters]). Permanent aviation and vessel warning lighting would be required on all WTGs and ESPs built by future offshore wind projects. At night, the required aviation lighting would consist of red lights on the nacelle flashing 30 times per minute, as well as mid-tower red lights flashing at the same frequency. Studies cited in Section 3.9 suggest that, generally, hazard lighting on WTGs more than 15 miles (24.1 kilometers) from the viewer would have negligible impacts. Depending on the selected location, a maximum of 38 WTGs are located within 15 miles (24.1 kilometers) of Martha's Vineyard and a maximum of 11 WTGs are within 15 miles (24.1 kilometers) of Nantucket, limiting the intensity of impacts from aviation hazard lights visible at night. Assuming future offshore wind developments do not commit to using ADLS systems, operational lighting from Alternative A combined with ongoing and planned actions would have a long-term, continuous, **moderate** overall impacts on cultural resources. If ADLS systems were used by future offshore wind developments, nighttime hazard lighting impacts on cultural resources from ongoing and planned actions, including Alternative A, would be reduced to **minor.**

Port utilization: Expansion: The Proposed Action would make use of the state's ongoing investment in the MCT at the Port of New Bedford, as well as private investments at Vineyard Haven Harbor, but was not itself the impetus for any such investments. As stated in Section A.8.6, these upgrades were undertaken in support of the Massachusetts/Rhode Island offshore wind industry as a whole. BOEM assumes that state and federal legal requirements to identify and assess—and to avoid, minimize, and/or mitigate—potential impacts on cultural resources were or would be followed as part of these expansions. As a result, the Proposed Action would have no impacts on cultural resources under this IPF. BOEM assumes that any port expansions necessitated by future offshore wind projects would also adhere to applicable regulations for evaluating and addressing impacts on cultural resources. Because the Proposed Action would have no impacts under this IPF, there would be no combined impacts.

Presence of structures: A Historic Properties VIA and subsequent VIA Addendum for the Proposed Action determined that the construction of the WTGs would adversely affect four historic properties: the Gay Head Light; Chappaquiddick Island TCP; the Nantucket Historic District National Historic Landmark comprising the islands of Nantucket, Tuckernuck, and Muskeget (COP Volume III, Appendix III-H.b; Epsilon 2020e); and the Vineyard Sound and Moshup's Bridge TCP (Vineyard Wind 2021b). The studies determined that an uninterrupted sea view, free of modern visual elements, is a contributing element to the NRHP eligibility of the four historic properties. As a result, the presence of visible WTGs from Alternative A alone 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, Alternative A alone would only affect southern views from these resources. To further minimize and mitigate Alternative A's effects, Vineyard Wind has voluntarily committed to the following measures:

- Avoiding use of the three turbine locations in the northwest corner of the WDA (i.e., those closest to Martha's Vineyard and Nantucket islands);
- Funding a mitigation plan to resolve impacts on the Gay Head Light pursuant to a NHPA Section 106 Memorandum of Agreement (MOA);
- Preparation of an Ethnographic Study and National Register Nomination for listing of the proposed Chappaquiddick Island TCP on the NRHP;
- Preparation of an Ethnographic Study and National Register Nomination for listing of the proposed Vineyard Sound and Moshup's Bridge TCP on the NRHP;
- 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 WDA (see Appendix D); and
- Use of non-reflective pure white (RAL Number 9010) or light grey (RAL Number 7035) paint on offshore infrastructure to minimize daytime visual effects.

The final minimization and mitigation of adverse effects will be determined through completion of BOEM's NHPA Section 106 review process and included as conditions of COP approval.

BOEM conducted a Historic Properties Cumulative Visual Effects Assessment to evaluate visual impacts on the Gay Head Light, Nantucket NHL, Chappaquiddick Island TCP, and Vineyard Sound and Moshup's Bridge TCP historic properties from the Proposed Action and the future offshore wind projects (ERM 2021). The expanded planned action's effects assessment determined the number of WTGs from Alternative A and future offshore wind projects that could be theoretically visible (based on distance, topography, vegetation, and intervening structures) from each of the four historic properties affected by Alternative A. The study also calculated the percentage of the total resource area from which at least one WTG would be visible (i.e., the percentage of the total land area of the resources where a viewer would be able to see one or more WTGs). The study assessed these values using the tip of the blade height for 14 MW (837 feet [255 meters]) and 12 MW (853 feet [260 meters]) turbines in order to simulate the maximum number of WTGs that could be theoretically visible from Alternative A and future offshore wind projects. The study also calculated the same values using the nacelle heights of the 14 MW (496 feet) and 12 MW (514 feet) turbines. Since the nacelle heights would be lower than the blade tips, the number of theoretically visible WTGs would be lower. Table 3.8-4 contains a summary of the study findings based on the blade tip analysis.

The Historic Properties Cumulative Visual Effects Assessment demonstrates that portions of over 608 WTGs could theoretically be visible from select, high elevations at each of the four resources. Substantially fewer WTGs would be visible from lower elevations or locations without clear south-facing seaward views. The Gay Head Light would be subject to the largest scale impacts of the four resources, with portions of up to 688 WTGs theoretically visible from the resource, with at least one WTG theoretically visible from 76 percent of the resource area, and with the closest WTG approximately 13.6 miles (21.9 kilometers) away from the lighthouse. The study also demonstrates, however, that the Nantucket NHL and Chappaquiddick Island TCP would be subject to comparatively smaller scale, less intense overall viewshed impacts. Portions of up to 645 and 636 WTGs (respectively) could be theoretically visible from individual locations within these resources, with the closest WTGs 12.8 and 14.4 miles (20.6 and 23.2 kilometers) away, respectively, from the closest location within each resource (generally, a south-facing shoreline). Within the Vineyard Sound and Moshup's Bridge TCP (especially from the Squibnocket Point area of southwestern Martha's Vineyard), up to 608 WTGs could theoretically be visible, with the closest WTG approximately 12.4 miles away. Observers would theoretically be able to see one or more WTG from a maximum of only 41 percent of the land area in the Chappaquiddick Island TCP, and 19 percent of the land area in the Nantucket NHL. This demonstrates the limited geographic extent of cumulative visual impacts from Alternative A and No Action Alternative.

In addition to the limited geographic extent of impacts, the intensity of visual impacts on these historic properties would be limited by distance, environmental, and atmospheric factors. Due to the distances between the historic properties and the WDAs, the WTGs from Alternative A and future offshore wind projects would appear relatively small to an observer, appearing to be less than 0.1 inch (0.25 centimeter) tall on the horizon. As discussed in Section 3.8.1.1, the visibility of WTGs would be further reduced by environmental and atmospheric factors such as cloud cover, haze, sea spray, vegetation, and wave height (COP Volume III, Appendix III-H.b; Epsilon 2020e). While these factors would limit the intensity of impacts, the presence of visible WTGs from ongoing and planned actions, including Alternative A, would have long-term, continuous, **moderate** impacts on the four historic properties listed above.

New cable emplacement/maintenance: Alternative A would result in construction of up to 57 WTGs and 2 ESPs, as well as jet plow embedment with limited dredging for installation of the offshore export cable and an inter-array cable system. Marine geophysical remote sensing studies performed for the proposed Project identified two shipwrecks, five potentially significant debris fields, and 31 submerged landform features (stream channel, lake, and estuarine landscape features) within the WDA and OECC. While the HRG and geotechnical studies did not find any direct evidence of pre-Contact period Native American cultural materials, the submerged landforms are considered culturally significant TCPs by regional Native American tribes as portions of a landscape occupied by their ancestors.

Disturbance and destruction of even a portion of a potential shipwrecks or identified submerged landform could threaten the scientific and/or cultural viability of these resources in their entirety as both potential repositories of scientific and archaeological knowledge, as well as their cultural significance to Tribes. For shipwreck and debris field resources, the severity of impacts would depend on the horizontal and vertical extent of the proposed disturbance relative to both the size of the cultural resource, but also relative to the nature of the information that may be lost from future archaeological and scientific understanding within that discrete portion of the resource. Vineyard Wind has voluntarily committed to avoiding the shipwrecks and debris fields, and would not impact these resources. BOEM determined that Alternative A alone would have long-term, localized, **negligible** impacts on shipwreck and debris field cultural resources.

Vineyard Wind has also voluntarily committed to removing one WTG placement location and rerouting the offshore export cable and WDA inter-array cables to avoid 12 of the 31 submerged landforms identified in the WDA and OECC (Epsilon 2019b). Construction of Alternative A would result in large-scale, permanent impacts on the remaining 19 submerged landforms that could not be avoided. Vineyard Wind has committed to working with the consulting parties, Native American tribes, BOEM, and the MHC to develop a specific treatment plan for mitigating impacts on unavoidable submerged landforms. For those unavoidable submerged landforms, additional mitigations to resolve impacts would be performed, as codified in a NHPA Section 106 MOA. Implementation of a treatment plan agreed to by all parties would likely reduce the magnitude of impacts on submerged landforms; however, the magnitude of these impacts would remain **major** due to the permanent, irreversible nature of the impacts.

Using the assumptions in Appendix A, Table A-4, future offshore wind projects would result in construction of 775 WTGs and 20 ESPs, as well as inter-array cable systems, and OECCs (3,398 acres [13,751 m^2] of seabed disturbance). The marine geophysical and geotechnical studies conducted for the proposed Project, a 2012 BOEM study (TRC 2012), and the NOAA Automated Wreck and Obstruction Information System and Electronic Navigational Chart databases suggest that the entire RI and MA Lease Areas covers areas with high probability for containing submerged cultural resources (TRC 2012). As with Alternative A, future 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. As with Alternative A, other projects would likely be unable to avoid impacts on all submerged landforms. In context of reasonably foreseeable environmental trends, the combined cable emplacement impacts on cultural resources from ongoing and planned actions, including Alternative A, would have localized, long-term, **minor** impacts on shipwrecks, downed aircraft, and debris fields, and long-term, widespread, unmitigated, **major** impacts on submerged landforms. BOEM has committed to working with Applicants, consulting parties, Native American tribes, and the MHC to develop specific treatment plans to address impacts on submerged landforms 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 submerged landforms; however, the magnitude of these impacts would remain **major**, due to the permanent, irreversible nature of the impacts.

Land disturbance: Vineyard Wind conducted desktop research, reconnaissance level, and intensive level archaeological surveys of the onshore component of the Proposed Action (COP Volume III, Appendix III-G; Epsilon 2020b). The desktop research identified one previously identified archaeological site (19BN-829) that could be impacted by ground-disturbing activities associated with the construction of the OECC. The additional surveys identified zones of high archaeological sensitivity in the southern ends of the noticed route in Barnstable, and large zones of moderate archaeological sensitivity along a section of the noticed route along Strawberry Hill Road, and Wequaquet and Phinneys lanes. Based on these findings, Vineyard Wind has committed to performing archaeological monitoring of Project construction activities within the staging areas for the HDD and during installation of upland cable within the identified zones of high and moderate archaeological sensitivity.

The intensive level survey of the Barnstable Switching Station was performed in two phases: the initial phase investigating a 6.4-acre (25,900 m^2) substation site, and a subsequent investigation for an approximately 2.2 acres (8,903 m^2) expansion along the west side of the original substation site. The majority of the 2.2-acre (8,903 m^2) area expansion has been previously disturbed, but 0.64 acre (2,428 m^2) required intensive level survey for terrestrial cultural resources. The survey of the 0.64-acre (2,428 m^2) expansion area did not identify any pre- or post-contact cultural resources (Ritchie 2020). Two isolated cultural resources finds, labeled Vineyard Wind Find Spots 1 and 2, were identified during the initial survey and no cultural resources were identified during the subsequent investigations. These two isolated finds were recommended not eligible for listing on the NRHP, and no additional investigations would be warranted. MHC concurred with these recommendations in a letter dated January 15, 2019 (Ritchie 2020). Vineyard Wind has completed terrestrial archaeological investigations aligned with Massachusetts's state requirements in all portions of the terrestrial archaeological APE area associated with this substation expansion. Considering these changes, the impacts of the Proposed Action on terrestrial cultural resources are still expected to be **minor**.

Vineyard Wind's onshore cultural resource investigations determined that Alternative A would not impact any known terrestrial cultural resources. Vineyard Wind has committed to conducting archaeological monitoring during construction in areas previously determined to have a moderate to high potential for undiscovered archaeological resources. Based on the results of Vineyard Wind's terrestrial archaeological investigations, and considering the possible presence of undiscovered resources, onshore construction of Alternative A would have localized, long-term, **minor** impacts on terrestrial cultural resources.

BOEM could reduce potential impacts of onshore construction by requiring one or both of the following mitigation measures as a condition of COP approval (Appendix D).

- Vineyard Wind must avoid any identified archaeological resource or TCP; or, if Vineyard Wind cannot avoid the resource, they 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 C.F.R. § 800.6. Avoidance would result in **negligible** direct impacts whereas data recovery investigations would result in **minor** impacts to terrestrial archaeological resources.

- Archaeological monitoring during onshore construction in areas identified as having high or moderate archaeological sensitivity and implementation of a terrestrial post-review discoveries plan would reduce potential impacts to any previously undiscovered archaeological resources (if present) encountered during construction. Archaeological monitoring and the implementation of a post-review discoveries plan would reduce potential impacts to undiscovered archaeological resources to **negligible** by preventing further physical impacts to the archaeological resources encountered during construction.

Construction of onshore components for future offshore wind developments could result in impacts on known cultural resources and undiscovered cultural resources (if present). Ground-disturbing construction activities could impact undiscovered archaeological sites. BOEM anticipates that federal (i.e., NEPA and NHPA Section 106) and state level requirements to identify cultural resources, assess impacts, and implement measures to avoid, minimize, and/or mitigate impacts would minimize impacts on cultural resources from the reasonably foreseeable wind developments. As a result, construction of the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in localized, long-term, **minor** impacts on terrestrial cultural resources.

Climate change: Operation of Alternative A would marginally reduce or displace emissions from conventional power generation, thereby contributing to slowing or arresting global warming and associated climate change and also having a long-term, **negligible** to **minor beneficial** impact cultural resources. Future offshore wind projects would have similar beneficial impacts, but on a larger scale. Due to the relatively small contribution of the offshore projects compared to global emissions, the magnitude of these **beneficial** impacts would remain **negligible** to **minor**.

In summary, Alternative A alone would have **negligible** to **major** impacts on cultural resources. Impacts would be reduced through the NHPA Section 106 review process as a result of the commitments made by Vineyard Wind and the implementation of a treatment plan to resolve adverse effects to 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. However, neither of these impact reductions would result in different impact ratings than those described above given the fact that the damage to submerged landform features is irreversible, even with mitigation.

Higher impacts, ranging from **moderate** to **major**, 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, and/or mitigation. These NHPA-required, "good faith" efforts to identify historic properties and address impacts resulted in or contributed to Vineyard Wind making a number of commitments to reduce the magnitude of impacts on cultural resources, including, but not limited to, the use of ADLS hazard lighting (if approved), the relocation of three WTG positions, rerouting the OECC and inter-array cable systems, the use of non-reflective pure white and light grey paint on offshore structures, funding mitigation measures for the Gay Head Light, and the development of a treatment plan with consulting parties to address impacts on submerged landforms (Appendix D). 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 the future offshore wind projects as they complete the NHPA Section 106 review process. Thus, the overall impacts on historic properties from Alternative A would likely qualify as **moderate** because a notable and measurable impact is anticipated, but the resource would likely recover completely when the impacting agent were gone and/or remedial or mitigating action were taken. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.8.1.2.

In the context of other reasonably foreseeable environmental trends in the area, impacts of individual IPFs resulting from planned actions, including Alternative A, would range from **negligible** to **major**. Considering all the IPFs together, BOEM anticipates that the impacts associated with Alternative A would result in **moderate** impacts on cultural resources due to the long-term or permanent and irreversible impacts on the Gay Head Light, Chappaquiddick Island TCP, Nantucket NHL, and submerged landforms.

3.8.3. Consequences of Alternatives C, D1, and D2

The impacts resulting from individual IPFs associated with Alternatives C, D1, and D2 alone on cultural resources would be the same as those of Alternative A: **negligible** to **minor** impacts, except for potentially **moderate** impacts on the Gay Head Light, Nantucket NHL, and Chappaquiddick Island TCP historic properties, and **major** impacts on submerged landforms.

In context of reasonably foreseeable environmental trends, the impacts on cultural resources from ongoing and planned actions, including Alternatives C, D1, and D2, would likely be similar to those of Alternative A, with individual IPFs generating **negligible** to **minor** impacts for some IPFs, and potentially **moderate** impacts on the Gay Head Light, Nantucket NHL, and Chappaquiddick Island TCP, and **major** impacts on submerged landforms. In context of reasonably foreseeable environmental trends, the overall impacts from ongoing and planned actions including each alternative would be **moderate** due to the long-term or permanent and irreversible impacts on the Gay Head Light, Chappaquiddick Island TCP, Nantucket NHL, and submerged landforms.

3.8.4. Consequences of Alternative E

Alternative E would entail the construction of 57 to 84 WTGs, each with generation capacity ranging from approximately 9.5 to 14 MW. Because Alternative E could involve a greater number of WTGs (84 or less in 100 of the 106 proposed locations compared to no more than 57 WTGs evaluated under Alternative A), it could increase seafloor disturbance compared to Alternative A, resulting in increased impacts on cultural resources: **minor** to **major**, overall.

In context of reasonably foreseeable environmental trends, combined impacts on cultural resources from ongoing and planned actions, including Alternative E, would be very similar to those of Alternative A, with individual IPFs leading to impacts ranging from **negligible** to **minor** for some IPFs, potentially **moderate** impacts on the Gay Head Light, Nantucket NHL, and Chappaquiddick Island TCP historic properties, and **major** impacts on submerged landforms. The overall impacts of Alternative E when combined with past, present, and reasonably foreseeable activities on cultural resources would be **moderate** due to the long-term or permanent and irreversible impacts on the Gay Head Light, Chappaquiddick Island TCP, Nantucket NHL, and submerged landforms.

3.8.5. Consequences of Alternative F

The northern transit lane within the WDA could result in the relocation of 16 to 34 WTG placements further offshore, a 12 to 61 percent increase in the size of the WDA further south (depending on whether the Proposed Action or Alternative D2 layout is used and how wide the transit lane is), and an associated increase the amount of inter-array cables and OECC due to the placement of WTGs further south in the lease area (Section 2.1.5). BOEM anticipates the impacts of Alternative F alone on the Gay Head Light, Nantucket NHL, Chappaquiddick Island TCP, and Vineyard Sound and Moshup's Bridge TCP would be similar to Alternative A, although there could be some reductions in visual impacts based on final WTG locations. Alternative F would also likely result in similar impacts on shipwreck, down aircraft, and associated debris fields, as BOEM would require additional marine cultural resource surveys to identify and avoid these types of resources. The impacts from the combination of the new Alternative F with Alternative A or Alternative D2 layout is expected to be similar to combinations with the other alternatives. Consequently, these other potential combinations are not separately analyzed here.

Selection of Alternative F would likely result in similar but fewer impacts on submerged landforms. While an increase in the length of the OECC and expansion of the inter-array cable network could increase the geographic extent and the number of submerged landforms impacted, this could be offset by the relocation of WTGs from the transit lane area and associated inter-array cabling further offshore to portions of the WDA with a lower to non-existent potential to contain intact ancient landform features (Bright et al. 2013). The inundation of the Massachusetts Lease Areas proceeded from southwest to northeast with the southern and eastern half of the Massachusetts Lease Areas occupied only until circa 11,000 Before Present, while portions of the northern and western half could have been occupied for an additional eleven hundred years. This difference in the relative lengths of potential occupation suggests that the southern and western portions of the Massachusetts Lease Areas contain fewer ancient landform features compared to the northern and eastern portions. In addition, the results of Vineyard Wind's marine archaeological surveys in the WDA indicate that the submerged landform features in the WDA are far more discontinuous and isolated compared to those in the OECC, and that this trend increases as distance from land increases, consistent with Bright et al. 2013 and reiterated by Vineyard Wind during BOEM's August 18, 2020, Section 106 Meeting on Mitigations for Adverse effect to Ancient Landform Features (BOEM 2020f). As a result, ancient landforms in the southern portions of the WDA, if they remain, are likely to be easier to avoid, potentially reducing the number and extent of impacts if WTGs are relocated further south under Alternative F.

If the Alternative F relocation of 16 to 34 WTG placements and 12 to 61 percent increase in the size of the WDA decreases seafloor impacts closer to shore and increases impacts further offshore, it could reduce the number of cultural resources impacted. Due to these offsetting factors, the likely impacts on submerged landforms from the Alternative F are anticipated to be similar to Alternative A: **negligible** to **minor** impacts on shipwreck, downed aircraft, and associated debris field resources and **major** impacts on submerged landforms.

In context of reasonably foreseeable environmental trends, combined impacts on cultural resources from ongoing and planned actions, including Alternative F, would be very similar to those of Alternative A, with individual IPFs leading to impacts ranging from **negligible** to **minor** for some IPFs, and potentially **moderate** impacts on the Gay Head Light, Nantucket NHL, Chappaquiddick Island TCP, and Vineyard Sound and Moshup's Bridge TCP historic properties, and **major** impacts on submerged landforms. The overall impacts of Alternative F on cultural resources would be **moderate** due to the long-term or permanent and irreversible impacts on the Gay Head Light, Chappaquiddick Island TCP, Nantucket NHL, Vineyard Sound and Moshup's Bridge TCP, and submerged landforms.

BOEM has qualitatively evaluated the collective impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. To the extent additional transit lanes are implemented in the future outside the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located further from shore. If in the future all six transit lanes were implemented, the overall number of WTGs would decrease but would lead to increased impacts on submerged landforms from longer OECC routes, as well as installation of WTGs in areas further offshore with fewer archaeological resources. The significance of these impacts may be somewhat reduced as the potential for impacting archaeological resources within submerged landforms decreases with increased distance from shore.

3.8.6. Comparison of Alternatives

As discussed above, most alternatives would have similar levels of impact on cultural resources. Alternatives C and F could have marginally lower visual impacts on the Gay Head Light Nantucket NHL, Chappaquiddick Island TCP, and Vineyard Sound and Moshup's Bridge TCP, due to reduced visual impacts, depending on WTG placement. Alternatives D, E, and F could have increased impacts on marine archaeological resources, due to increased seafloor surface disturbance. Furthermore, in the context of reasonably foreseeable trends, the combined impacts on cultural resources from ongoing and planned actions, including Alternatives C, D, and F, would be very similar to those of Alternative A; however, the overall impacts of Alternative E on cultural resources would be larger than those of Alternative A. Alternative C would be similar to Alternative A in overall impacts but could result in reduced visual impacts on the Gay Head Light, Chappaquiddick Island TCP, Nantucket NHL, and Vineyard Sound and Moshup's Bridge TCP. However, the combined impacts on cultural resources from ongoing and planned actions, including any action alternative, would likely be very similar because the majority of the impacts of any alternative come from future offshore wind development, which does not change between alternatives. Therefore, the overall impact of any action alternative when combined with other planned actions would be similar. See Table 2.4-1 for a comparison of alternative impacts.

3.8.7. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures as presented in Appendix D. Thus, no WTGs or inter-array cable would be placed within the northernmost portion of the WDA, more WTGs and inter-array cable may be placed in the southern portion of the WDA and may extend beyond the limits of the WDA proposed in the COP, although not beyond the boundaries of Lease Area OCS-0501, and no more than 84 WTGs would be allowed. Under the Preferred Alternative, the six northernmost positions would be relocated to the southern portion of the lease area, thereby reducing visual impacts from those expected under Alternative A. The Preferred Alternative would reduce potential impacts from offshore construction by requiring the mitigation measures presented in Appendix D in comparison to Alternative A. If these WTGs are relocated to an area that has not been investigated as part of the previous marine archaeology surveys, then BOEM would require those areas be investigated. If historic properties are identified in these newly proposed locations, BOEM would require Vineyard Wind to take actions to avoid, minimize, or mitigate the physical effects to resources. Any requirements for additional surveys to identify historic properties and resolve adverse effects thereto would be included in the MOA generated at the end of the NHPA Section 106 review.

BOEM anticipates that the Preferred Alternative would have **negligible** to **major** impacts on submerged landforms and the Gay Head Light, Nantucket NHL, Chappaquiddick Island TCP, and Vineyard Sound and Moshup’s Bridge TCP historic properties. Final mitigations would be determined through BOEM’s NHPA Section 106 review process and included as conditions of approval of the COP.

3.9. Recreation and Tourism

3.9.1. No Action Alternative and Affected Environment

This section discusses existing recreation and tourism resources and activities within the geographic analysis area described in Table A-1 in Appendix A and shown on Figure A.7-9. The geographic analysis area includes the RI and MA Lease Areas plus a 38.4-mile (33.4-nautical-mile) area measured from the borders of the proposed Project WDA, which is the area from which any portion of the proposed Project structures (as proposed in the 2020 COP; Epsilon 2018a, 2019c, 2020a, 2020b) would potentially be visible based only on the obscuring effect of the curvature of the earth’s surface. Table 3.9-1 contains a summary based on the IPFs assessed of ongoing and future offshore activities other than offshore wind, which is discussed below.

The geographic analysis area includes southern Cape Cod, Nantucket, Martha’s Vineyard, and nearby smaller islands. The coastal and ocean environment of the analysis area supports ocean-based recreation and tourist activities that include recreational boating and fishing, charter fishing, shellfishing, sailboat races, sightseeing, bird and wildlife viewing (including whale watching), swimming, visiting beaches, hiking, and other activities. 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 and sailboat races, charter and tour boats, kayaking, canoeing, and paddleboarding. As indicated in Section 3.6, recreation and tourism contribute substantially to the economies of the coastal counties of Massachusetts.

The scenic quality of the coastal environment is important to the identity, attraction, and economic health of many of the coastal communities. The visual qualities of historic coastal towns, which include marine activities within small-scale harbors and the ability to view birds and marine life, are important community characteristics.

Commercial, marine-oriented recreational businesses offer boat rentals, private charter boats for fishing, whale watching and other wildlife viewing, and canoe or kayak tours. Many of the activities make use of coastal and ocean amenities that are free for public access. Nonetheless, these features function as key drivers for coastal businesses, particularly those within the recreation and tourism sectors. As discussed in Section 3.6, recreation and hospitality are major sectors of the economy in Barnstable, Dukes, and Nantucket Counties, supported by the ocean-based recreation uses.

Muskeget Channel and Nantucket Sound off the coasts of Cape Cod, Nantucket, and Martha’s Vineyard are extensively used for recreational boating and fishing. A 2012 survey of recreational boaters along the northeastern U.S. coast found that the highest density of recreational vessel routes in the geographic analysis area was within Nantucket Sound and within 1 nautical mile of the coastline. More than half (52.4 percent) of recreational boating occurred within 1 nautical mile of the coastline (Starbuck and Lipsky 2013). Fishing was the most popular activity for recreational boaters. Several popular recreational fishing areas are near the WDA (Section 3.10 and Figure 3.10 11), including “The Dump” south of the lease area and “Gordon’s Gully,” “The Owl,” “The Star,” and the “Inside Fingers” within and near the WDA (COP Volume III, Section 7.6.5; Epsilon 2020b).

Although data on recreational fishing specific to the geographic analysis area are not available, NOAA compiles estimates by state of recreational catch, number of participants, and number of trips by state. More than 5.2 million residents of Atlantic coast states participated in marine recreational fishing in 2018, accounting for over 129 million trips and 574 million fish caught. About 5 percent of these trips (approximately 6.7 million) originated in Massachusetts, generated by an estimated 380,000 participants from Massachusetts and 169,000 participants from other states. An estimated 13 percent (about 17.3 million) of fishing trips originated in the nearby states of New York, Connecticut, and Rhode Island. The most commonly caught non-bait species (in numbers of fish) were striped bass, spotted seatrout, black sea bass, bluefish, and scup. The largest harvests by weight were striped bass, dolphinfish, bluefish, scup, and black sea bass (NOAA 2020d).

Fishing for Atlantic HMS, defined as federally regulated sharks, blue and white marlin, sailfish, roundscale spearfish, swordfish, and federally regulated tunas, occurs further offshore than most other recreational fishing, and is therefore more likely to overlap with areas where future offshore wind development would occur. There were 20,020 angling permit holders for Atlantic HMS in 2016 (Hutt and Silva 2019). In 2016, 14 percent of HMS angling trips began in Massachusetts; only Florida (16 percent of trips) had a higher percentage of trip originations. Three percent of trips began in Rhode Island (Hutt and Silva 2019).

A 2020 BOEM study provides a baseline assessment of HMS fishing in southern New England, using an online survey (from August 2019 through May 2020), data from the NMFS Large Pelagics Intercept Survey, and tagging data (Kneebone and Capizzano 2020). The 171 online survey respondents included 136 private anglers, 34 charter/headboat captains, and one unknown respondent. All respondents reported using mobile fishing tactics (trolling, drifting, casting/run), and some also reported using stationary (anchoring) tactics to target HMS (Kneebone and Capizzano 2020). Large fleets of 50 to 100 recreational vessels sometimes congregate in small geographic areas when targeting popular HMS.

From 2002 through 2018, approximately 12 percent of HMS trips and 18 percent of tagging events in southern New England occurred within the RI and MA Lease Areas (Kneebone and Capizzano 2020). From 2002 to 2018, HMS trips in the Vineyard Wind lease area (OCS-A-0501) represented 1 to 5 percent of total trips in southern New England and 6 to 28 percent of trips in the RI and MA Lease Areas, depending on the year (Kneebone and Capizzano 2020). Trips within the Vineyard Wind lease area primarily originated in Massachusetts and Rhode Island. The same was true for the RI and MA Lease Areas overall, although a notable number of trips also originated in Connecticut and New York (Kneebone and Capizzano 2020). As noted in Section 3.10, the greatest amount of HMS fishing effort occurred west of the RI and MA Lease Areas in the waters south and east of Montauk Point and Block Island (Figure 3.10-11 in Appendix B).

NMFS's Social Indicator Map (NMFS 2019) classifies communities as having varying levels of recreational fishing engagement and reliance. Several communities within and near the geographic analysis area have medium to high levels of recreational fishing engagement and reliance, including the towns of Falmouth, Mashpee, Barnstable, and West Yarmouth on Cape Cod, as well as Tisbury/Vineyard Haven on Martha's Vineyard and the Town of Nantucket. The communities around ports that would be used to support offshore wind (New Bedford, ProvPort, Brayton Point, Davisville) have low recreational fishing reliance and medium recreational fishing engagement. The Narragansett/Point Judith communities surrounding the regional fishing port of Point Judith have high recreational fishing engagement and medium-high reliance.

Barnstable County has more than 150 public beaches, several private beaches, 30 harbors, 40 marinas and boatyards, and approximately two dozen private boating and yacht clubs (COP Volume III, Section 7.5.1.1; Epsilon 2020b). Cape Cod National Seashore is located along the county's eastern coast. The Town of Barnstable has 170 miles (274 kilometers) of coastline with only 9.4 miles (15 kilometers) available for public recreation, of which approximately 2.4 miles (4 kilometers) are publicly controlled and easily accessible (Ridley 2018). The 14 public beaches account for 133 acres (0.54 km^2), while public boat landings occupy 12 acres (0.05 km^2). The town issued 2,760 recreational shell-fishing permits in 2017. During the summer, the public beaches are crowded, and beach parking lots frequently reach capacity by mid-morning. The Town of Yarmouth's 39 miles (62.8 kilometers) of saltwater shorefront form the backbone of the town's tourist-based economy. The most heavily used beaches are on Cape Cod Bay, Lewis Bay, and Nantucket Sound. The town operates four public marinas and nine boat ramps.

Swimming, fishing, shellfishing, and boating occur at Lewis Bay, Bass River, Parker's River, Nantucket Sound, Bass Hole, and Cape Cod Bay (Town of Yarmouth 2018).

The geographic analysis area incorporates southern Cape Cod, including the Covell's Beach landfall site on Craigville Beach Road near the paved parking lot entrance to Covell's Beach, which is a public beach owned by the Town of Barnstable.

The analysis area includes all of Dukes County and Nantucket County. Dukes County has five harbors, two marinas, three yacht clubs, and 15 public beaches. Recreational boaters use all of the harbors. Martha's Vineyard, the largest island in the County, has 211 miles (340 kilometers) of shoreline, of which about 68 miles (109 kilometers) are publicly accessible (Martha's Vineyard Commission 2010). Nantucket County has about 110 miles (177 kilometers) of shoreline, of which 80 miles (129 kilometers) are sandy beach open to the public. Nantucket has two harbors, both of which are popular seasonal destinations for recreational and commercial vessels. The island also has two yacht clubs, multiple marinas, and two public access boat ramps (COP Volume III, Section 7.5.1.1; Epsilon 2020b). For both islands, the coastal and rural landscapes, small towns, fishing fleets, and numerous historical resources provide a character and setting that attract residents, businesses, seasonal residents, and visitors.

3.9.1.1. Future Offshore Wind Activities (without Proposed Action)

BOEM expects future offshore wind activities to affect recreation and tourism through the following primary IPFs. The maximum-case scenario for recreation and tourism differs depending on the specific topic.

- Impacts on recreational fishing and boating (as discussed for the Presence of structures IPF) are based on the state demand within the RI and MA Lease Areas being met using only 8 MW WTGs. This would result in a total of 957 WTGs and 20 ESPs, for a total of 977 foundations in the RI and MA Lease Areas.
- All other IPFs and impacts assume that the state demand within the RI and MA Lease Areas would be satisfied using 12 or 14 MW WTGs, resulting in a total of 775 WTGs and 20 ESPs, for a total of 795 foundations.

Anchoring: This IPF would potentially impact recreational boating both through the presence of an increased number of anchored vessels within the geographic analysis area and through 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 development of future offshore wind between 2022 and 2030 would affect recreational boaters. The greatest volume of anchored vessels would occur in offshore work areas during construction. The Vineyard Wind 1 COP estimated that an average of 25 and a maximum of 46 vessels would be present at the offshore WDA at any given time during construction, including an average of four and a maximum of six vessels deployed along sections of the OECC during installation (COP Volume III, Section 7.8.2.1.2 and Appendix III-I; Epsilon 2020b). Future offshore wind projects may generate similar numbers of active and/or anchored vessels, depending on project size and construction schedule. Anchored construction-related vessels within 12 nautical miles of the shore may be within temporary safety zones established in coordination with the USCG for active construction areas (Section 3.11.2). Future offshore wind development in the geographic analysis area is anticipated to result in increased survey activity and overlapping construction periods beginning in 2022, with as many as four projects (not including the Proposed Action) under construction at one time in 2024, with others in surveying, permitting, or operational phases.

Vessel anchoring would also occur during maintenance and monitoring during operations. Following construction of future offshore projects (if approved), the presence of about 12 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.

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 3.3.1.1) and sightseeing (primarily whales, but also dolphins and seals). 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.

Light: Construction-related nighttime vessel lighting would be used if future 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 four future 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 south-facing 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. At night, required aviation lighting on the WTGs would consist of red lights on the nacelle flashing 30 times per minute, and mid-tower red lights flashing at the same frequency. Based on an assumed nacelle-top height of 514 feet (156.7 meters) AMSL, the nacelle-top warning lights on WTGs could theoretically be visible from up to approximately 35 miles (56 kilometers) away from viewers standing on the shore (farther for viewers from elevated positions). As a result, warning lighting from up to 709 WTGs could theoretically be visible within the geographic analysis area, depending on viewer location, intervening vegetation and topography, and atmospheric conditions.

A University of Delaware study evaluating the impacts of visible offshore WTGs on beach use found that WTGs visible more than 15 miles (24.1 kilometers) 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 impact 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 envisioned in the geographic analysis area would be more than 15 miles (24.1 kilometers) from coastal locations with views of the WTGs.

The southern shores of Martha's Vineyard and Nantucket located within the viewshed of the WTG lights include landscapes characterized by open beaches, coastal dunes, bluffs, and salt ponds/tidal marshes. Residential and nonresidential development intended for recreational use are widely scattered in this area. Other visible infrastructure includes utility lines and roadways. Because of the low development density, existing nighttime lighting is limited. Impacts on the visual character and viewer experience of the nighttime landscape would be more pronounced for views along the southern shores of Martha's Vineyard and Nantucket that can be currently characterized as undeveloped, where lighting from human infrastructure and activities is not dominant or even not visible at all. 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 not impact 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 south-facing coastal and elevated areas, with less impact on the recreation and tourism industry as a whole.

Vineyard Wind has committed to use ADLS for the proposed Project (Section 3.9.2). ADLS would only activate WTG lighting when aircraft enter a predefined airspace. For the Proposed Action, this was estimated to occur 235 times during the year, for a total of less than 4 hours per year (less than 0.1 percent of annual nighttime hours) (COP Volume III, Appendix III-N; Epsilon 2020b). If implemented for other wind energy projects in the RI and MA Lease Areas, depending on exact location and layout, ADLS would likely result in similar limits on the frequency of

WTG aviation warning lighting use for future offshore wind projects. Implementation of ADLS could thus reduce the amount of time that WTG lighting is visible, thereby making WTG lighting visible only sporadically, rather than continuously at night. This would significantly reduce the already minimal impacts on recreation and tourism associated with lighting on WTGs.

New cable emplacement and maintenance: Under the No Action Alternative, future offshore wind export cables from the RI and MA Lease Areas could cross 1,310 miles (2,108 kilometers), while inter-array cables could total 1,480 miles (2,382 kilometers). Specific cable locations associated with future offshore wind projects are unknown, and therefore have not been identified within the geographic analysis area, with the exception of the Vineyard Wind 2 Project cable, which would use the same offshore cable corridor as the Proposed Action. Cables for other future offshore wind projects would likely be emplaced within the geographic analysis area between 2022 and 2030. Based on the assumptions in Appendix A, these cables could affect up to 3,400 acres (13.7 km^2). Cables for the Equinor and Mayflower offshore wind projects would cross Nantucket Sound; cables for Bay State Wind would be in the geographic analysis area but not within Nantucket Sound.

Offshore cable emplacement for future 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 (Table A-1 in Appendix A). 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 impact 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.

Noise: Noise from construction, pile driving, G&G survey activities, trenching, operations and maintenance, 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 G&G 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 the safety zones established by USCG within 12 nautical miles of the coast, which would be off-limits to boaters. Noise from pile driving, the noisiest aspect of WTG installation, is estimated to be 60 dB on the A-weighted scale at a distance of 1 nautical mile from the construction zone (COP Volume III, Appendix III-I, Section 7.5.1.1; Epsilon 2020b), comparable to the noise level of a normal conversation (OSHA 2011). Pile-driving noise would be produced intermittently during construction of each project for approximately 2 to 3 hours per foundation or for 4 to 6 hours per day for the installation of two foundations per day. One or more projects may install more than one foundation per day, either sequentially or simultaneously over a 6- to 10-year construction period (Table A-6) and pile driving would likely occur during the same months that recreational boating is most popular (May through October).

During operations, the continuous noise generated by WTG operation, as measured at the Block Island Wind Farm, minimally exceeds ambient levels at 164 feet (35.4 meters) from the WTG base. In addition, based on the results of Thomsen et al. (2015) and Kraus et al. (2016b), sound pressure levels would be expected to be at or below ambient levels at relatively short distances from WTG foundations. Maintenance operations could temporarily produce localized noise.

Accordingly, the impact of noise on recreation and tourism during construction would be adverse, intense, and disruptive, but short-term and localized. Multiple construction projects at the same time would increase the number of locations within the geographic analysis area that experience noise disruptions. The impact of noise during operation and maintenance would be localized, continuous, and long-term, with brief more intensive noise during occasional repair activities.

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 RI and MA Lease Areas and along OECC routes, as discussed in Sections 3.3, 3.4, and 3.10. G&G survey noise and pile driving would cause the most impactful noises. Because most recreational fishing takes place closer to shore than the RI and MA Lease Areas, only a small proportion of recreational fishing would be impacted by the construction within the RI and MA Lease Areas, where most of the noise impacts would occur. Recreational fishing for HMS such as tuna, shark, and marlin are more likely to be impacted, as these fisheries are farther offshore than most fisheries and, therefore, more likely to experience temporary impacts resulting from the noise generated by future 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 3.4, BMPs can minimize exposure of individual mammals to harmful impacts and avoid measurable, population-level effects.

Noise from operational WTGs would have little effect on finfish, invertebrates, and marine mammals; therefore, little effect on recreational fishing or sightseeing.

Future offshore wind surveying and construction would occur within the geographic analysis area between 2022 and 2030. Based on the discussion above, future 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 future offshore wind projects in Table A-6 in Appendix A indicates the possibility of up to four wind (not including the Proposed Action) projects simultaneously under development in the RI and MA Lease Areas. As indicated in Appendix A, up to775 offshore WTGs and 20 ESPs could be installed within a 6- to 10-year period within the RI and MA Lease Areas. No long-term, adverse impacts are anticipated, provided that mitigation measures are implemented to prevent population-level harm to fish and marine mammal populations.

Port utilization: The geographic analysis area for recreation and tourism contains no ports anticipated to be used for staging and construction support for future offshore wind development, although the area does include Vineyard Haven Harbor, which would be used by the Proposed Action for operational support. Ports outside the geographic analysis area for recreation and tourism that are likely to be used for staging and construction, such as New Bedford, Brayton Point, ProvPort, and Davisville/Quonset Point, may provide facilities for recreational vessels, or may be on waterways shared with recreational marinas, and may experience increased activity and undergo expansion and dredging. The ports listed above and other regional ports suitable for staging and construction of future offshore wind 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 would provide long-term benefit to recreational boating if the improvements result in increased berths and amenities for recreational vessels, improved navigational channels, or opportunities to separate recreational boating from commercial shipping.

Presence of structures: The placement of 957 WTGs and 20 ESPs within the RI and MA Lease Areas in the geographic analysis area (assuming the use of 8 MW structures) would be the maximum-case scenario for recreational fishing and boating, as stated in the introduction to this section. 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; navigation hazards; space use conflicts; presence of cable infrastructure; and visual impacts. The future offshore wind structures could have beneficial impacts on recreation through fish aggregation and reef effects.

A 2020 study examined reactions of recreational boaters to potential offshore wind development in the RI and MA Lease Areas. The study was based on a survey of 2,500 recreational boaters who use a port in Rhode Island, evenly split between sailing and motor vessels (including vessels greater than 5 net tons or at least 26 feet [8 meters] in length) (Dalton et al. 2020). Survey respondents tended to prefer boating closer to the coast, south of Newport and near Block Island, as opposed to near the RI and MA Lease Areas. While the survey found that boating within 100 feet (30.5 meters) of an offshore wind facility would detract considerably from a boater's experience, the boaters who fished expressed less negative impact from boating near a turbine than those who do not fish. Recreational fishing boaters expected to catch more target species. The study concluded that a wind energy facility in the RI and MA Lease Areas would be unlikely to have significant impacts on recreational boaters because those boaters prefer to use waters closer to the coast, most recreational boaters from Rhode Island ports who choose to visit the RI and MA Lease Areas would likely keep their distance from new structures, and increased abundance of targeted fish species near offshore wind facilities would have positive impacts on the recreational fishing (Dalton et al. 2020).

BOEM anticipates that future offshore wind structures would be added intermittently in the RI and MA Lease Areas over an assumed 6- to 10-year period, and that these structures would remain until decommissioning of each facility is complete (up to 30 years from installation). A total of 977 structures are anticipated to be constructed within the geographic analysis area for recreation and tourism over the 6- to 10-year period (Figure A.7-9 in Appendix A).

The presence of future offshore wind structures would increase the risk of allision or collision with other vessels and the complexity of navigation within the RI and MA Lease Areas. Generally, the vessels more likely to allide with WTGs or ESPs would be smaller vessels moving within and near wind installations, such as recreational vessels. The USCG would need to adjust their search and rescue (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 3.12.2.1.

Future offshore wind development could require adjustment of routes for recreational boaters, anglers, sailboat races, and sightseeing boats, but the adverse impact of the future offshore wind structures on recreational boating would be limited by the distance offshore. The closest WTG could be about 10.6 miles (17.1 kilometers) from shore (a WTG position within Lease Area OCS-A-0486, as viewed from Squibnocket Beach South—Appendix A). A 2012 survey of recreational boaters along the northeastern U.S. coast found that the highest density of recreational vessels routes in the study area was within Nantucket Sound and within 1 nautical mile of the coastline. More than half (52 percent) of recreational boating occurred within 1 nautical mile of the coastline (Starbuck and Lipsky 2013). In 2011, NOAA estimated that 97 percent of the 2011 recreational boating from Massachusetts occurred within 3 nautical miles of shore (BOEM 2012b). Based on these findings, most recreational vessels would continue to navigate within 3 nautical miles of shore, and thus would not interact with offshore WTGs or ESPs. The owners of relatively large recreational vessels surveyed by Dalton et al. (2020) confirm the general preference for boating close to the coast (specifically 3 to 10 nautical miles from shore, compared to the RI and MA Lease Areas more than 17.4 nautical miles from shore).

Recreational boating farther from shore would be impacted by the presence of future offshore wind structures. Examples include recreational fishing (especially HMS fishing), long-distance sailboat races, sightseeing boats, and large sailing vessels. HMS fisheries are further offshore than most fisheries and therefore more likely to overlap with future offshore wind development. As noted above, in Section 3.10.1.1, and on Figure 3.10-11 in Appendix B, the greatest amount of recreational HMS fishing effort in southern New England from 2002 through 2018 occurred west of the RI and MA Lease Areas (Kneebone and Capizzano 2020), although HMS fishing occurred in specific locations within the RI and MA Lease Areas, including “The Dump,” “Coxes Ledge,” “The Fingers,” and “The Claw.” Fifty-eight members of the Rhode Island Party and Charter Boat Association stated that they fish in the Vineyard Wind WDA, particularly “Gordon’s Gully.” HMS fishing within the Vineyard Wind lease area accounted for up to 5 percent of HMS trips in southern New England and up to 28 percent of HMS trips in the RI and MA Lease Areas (Kneebone and Capizzano 2020). Commonly used mobile methods for HMS angling such as trolling and drifting may be incompatible with the presence of WTGs and ESPs, depending upon weather conditions and specific techniques. For example, trolling may involve trailing many feet of lines and hooks behind the vessel and then following large pelagic fish once they are hooked, posing navigational and maneuverability challenges around WTGs. These concerns notwithstanding, individual and for-hire recreational anglers have stated that the fish aggregation (including potential increases in HMS presence) and habitat conversion resulting from the presence of WTG and ESP structures would generally benefit recreational fishing (see Section 3.10.1 and Appendix K).

Several long-distance sailboat races may pass through the geographic analysis area, depending upon the route selected for a particular year, including the Transatlantic Race, Marion to Bermuda Race, and Newport Bermuda Race. Larger sightseeing boats travel to offshore locations where whale sightings are more likely. These recreational vessels would need to navigate around future offshore wind projects, or navigate through them while avoiding allisions.

In addition, sailing vessels with masts taller than the lowest elevation of WTG blade tips (for 8 MW WTGs, BOEM assumes that this would be 89 feet [27.1 meters] AMSL) would need to avoid WTGs, and would likely choose to avoid future offshore wind projects altogether. AIS data showed that two sailing vessels with a mast height greater than 89 feet (27.1 meters) AMSL traversed the WDA multiple times in 2016 and 2017 (COP Volume III, Appendix III-I; Epsilon 2020b).

The RI and MA Lease Areas would have an estimated 977 foundations with scour protection and 242 acres (1 km^2) of hard protection for inter-array cables, which results in an increased risk of recreational fishing gear loss or damage by entanglement. The cable protection would also present a hazard for anchoring, as anchors could have difficulty holding or become snagged and lost. Export cables are estimated to require 339 acres (1.4 km^2) of cable hard protection, of which a currently unknown proportion would be in the geographic analysis area. 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. Lessees in the RI and MA Lease Areas continue to engage with both the USCG and NOAA in developing a comprehensive aids-to-navigation plan for the entire RI and MA Lease Areas, including charting symbology and notes (Lewis 2020). Buried offshore cables would not pose a risk for most recreational vessels, as smaller vessel anchors would not penetrate to the target burial depth (6 to 8 feet [1.8 to 2.4 meters]) 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.

Future offshore wind structures could provide new opportunities for offshore tourism by attracting recreational fishing and sightseeing. The wind structures could produce artificial reef effects, attracting species of interest for recreational fishing and resulting in an increase in recreational boaters traveling farther from shore in order to fish within the RI and MA Lease Areas. The structures may also create foraging opportunities for seals, small odontocetes, and sea turtles, attracting recreational boaters and sightseeing vessels. In addition, the future offshore wind projects could attract sightseeing boats for tours. Although the likelihood of recreational vessels visiting the offshore WTG foundations would diminish with distance from shore, increasing numbers of offshore structures may encourage a greater volume of recreational vessels to travel to the WDAs. 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 3.10).

As it relates to visual impacts of presence of structures, the vertical presence of 14 MW WTGs (the tallest WTGs possible under the No Action Alternative) on the offshore horizon would create a visual contrast contrary to the horizontal form of the ocean's water surface and the line at the visual horizon that separates the ocean from sky. A viewer would experience changing views of multiple projects as they turn their heads and/or move along a shoreline or other area with views toward the lease areas. Towers closer to shore may block other more distant towers from view, and could produce a visual anomaly of the closer turbine appearing to have more than three blades. The white color of the turbines would also contrast at certain sun angles during the day. The motion of the WTGs would also draw a viewer's attention. The contrast would vary in visual dominance depending on the distance between the viewer and the WTGs, and would be influenced by atmospheric conditions and the viewers' visual acuity. The visual dominance created by the contrasting elements (form, line, color) would be static as viewed from a given stationary point along the shoreline but would vary with changes in sun angle and atmospheric conditions. Visual dominance created by contrasting elements would vary from offshore locations as floating vessels navigate toward or away from the WTGs.

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'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 a distance of 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) 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 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 (Ferguson et al. 2020). 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 that it would have a neutral impact, and 26 percent anticipated that offshore wind development would have an adverse impact (Ferguson et al. 2020).

As described under the IPF for light, the southern shores of Martha's Vineyard and Nantucket located within the viewshed of the WTGs are sparsely developed; however, public beaches and tourism attractions in these areas 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 nearly all 775 WTGs associated with the No Action Alternative (assuming 12 or 14 MW WTGs) could be visible from shorelines (depending on vegetation, topography, weather, atmospheric conditions, and the viewers' visual acuity), of which up to 34 (fewer than 5 percent) would be within 15 miles (24.1 kilometers) of shore. 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. Visual impacts would be more pronounced in views lacking development and outside of heavy recreation use times (i.e., when crowds of beachgoers do not impact the visitor's experience of the natural elements of the landscape). Based on the research cited above on the relationship between visual impacts and impacts on recreational experience, the impact of visible WTGs on recreation would be long-term, continuous, and adverse. Seaside locations on the southern coast of Nantucket and Martha's Vineyard could experience some reduced recreational and tourism activity, but the visible presence of WTGs would be unlikely to impact shore-based or marine recreation and tourism in the geographic analysis area as a whole.

Traffic: Future offshore wind project construction and decommissioning and, to a lesser extent, future 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 future offshore wind construction areas.

Vessel traffic for each project is not known; however, as an example, the Vineyard Wind 1 Project is projected to generate an average of 7 daily vessel trips between ports and offshore work areas over the entire construction phase, and an average of 18 vessel trips daily during peak construction activity (COP Volume III, Appendix III-I, Section 5.2.2; Epsilon 2020b). As shown in Table A-6 in Appendix A, between 2022 and 2030 as many as four offshore wind projects (not including the Proposed Action) could be under construction simultaneously (in 2024). During such periods, construction of offshore wind projects would generate an average of 24 to 72 vessel trips daily from Atlantic coast ports to worksites within the geographic analysis area, with as many as 184 vessels present (either underway or at anchor) at any given time.

Establishment of up to 12 future offshore wind projects could occur within the RI and MA Lease Areas between 2022 and 2030. Operations and maintenance activities for the Vineyard Wind 1 Project are anticipated to generate an average of one to three vessel trips per day between a port and the WDA for observation, with additional vessel trips occurring as needed for repair and maintenance activities. Based on the estimates for the Vineyard Wind 1 Project, operation of the No Action Alternative would generate an average of 12 to 36 vessel trips per day.

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 future offshore wind facility is under construction at the same time. Vessel traffic associated with future 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 impacts on recreational vessels.

3.9.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, recreation and tourism would continue to be influenced by regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind activities, and future offshore wind activities to have continuing impacts on recreation and tourism. 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. While the geographic analysis area has a strong tourism industry and abundant coastal and offshore recreational facilities, many of which are associated with scenic views, local jurisdictions face challenges maintaining the recreational resources. The primary concern for the ocean-based resources is protection of water quality. The following are recreation-related planning goals of the jurisdictions (Town of Barnstable 2010; Cape Cod Commission 2014; Martha's Vineyard Commission 2010; Ridley 2018):

- Restoring natural resources that support recreational opportunities by improving coastal water quality through enhanced wastewater treatment and stormwater management;
- Promoting ecotourism and balancing visitors needs with protection of the natural resources;
- Increasing availability of public water access;
- Improving recreational facilities for year-round residents, especially providing recreation centers and adequate athletic facilities; and
- Completing pathway networks and greenways.

BOEM anticipates that the impacts of ongoing activities, including ongoing vessel traffic and the noise and trenching from periodic maintenance or installation of piers, pilings, seawalls, or offshore cables, would be **negligible**. In addition to ongoing activities, planned actions other than offshore wind may also contribute to impacts on recreation and tourism. Planned actions that may have impacts include increasing size of commercial shipping vessels; new barge routes within the geographic analysis area, maintenance and dredging of harbors, and the installation of new towers, buoys and piers (Table 3.9-1). Offshore activities other than offshore wind would have only localized, temporary impacts on recreational boating and would not affect the area's scenic quality. BOEM anticipates that the impacts of planned actions other than offshore wind would be **minor.** BOEM expects the combination of ongoing activities and planned actions other than offshore wind to result in **minor** impacts on recreation and tourism, driven primarily by marine construction and dredging to install and maintain offshore cables, piers, seawalls, and harbors.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area combined with ongoing activities, reasonably foreseeable environmental trends, and planned actions other than offshore wind would result in **moderate** adverse impacts and **minor beneficial** impacts. Future 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 impacts 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 gear entanglement and loss, and visual impacts from offshore structures, although few WTGs would be within 15 miles (24.1 kilometers) of shore (the point at which adverse impacts on tourism may outweigh beneficial impacts). BOEM anticipates that the future offshore wind activities in the analysis area would result in **minor beneficial** impacts due to the presence of offshore structures and cable hard cover, which could provide opportunities for fishing and sightseeing.

3.9.2. Consequences of Alternative A

This section identifies potential impacts of the proposed Project on recreation and tourism resources and activities, including impacts on visual resources from the proposed Project. BOEM defines visual resources consistent with Bureau of Land Management's definition; that is, the visible physical features on a landscape, including natural elements such as topography, landforms, water, vegetation, animals, manmade structures, and other features (BLM 1984).

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on recreation and tourism:

- If Vineyard Wind were to install 57, 14 MW WTGs instead of the potential 100, 8 MW WTGs initially evaluated, the maximum height of the blade tip for 14 MW WTGs would be 837 feet (255 meters) above the surface, compared to 696 feet (212 meters) for the 8 MW WTGs. The nacelle height of the 14 MW WTGs would be 495 feet (150.9 meters) above the surface, compared to 397 feet (121 meters) for the 8 MW WTGs. Because the WTGs would exceed 699 feet (213 meters), FAA regulations require additional mid-tower lighting, in addition to lighting at the top of the nacelle (FAA 2015). The taller WTGs and additional lighting would be visible from additional locations within the geographic analysis area. As a result, the maximum-case scenario for recreation and tourism differs depending on the specific topic.
  - The 14 MW WTG option represents the maximum-case scenario for visual impacts. Although this option requires only 57 WTGs, the taller WTGs would be visible from more coastal locations than the smaller, 8 MW WTGs.
  - The 8 MW WTG option represents the maximum-case scenario for recreational fishing and boating due to the need for 100 WTGs, with resulting increase in navigational complexity, as compared to the 57 structures needed if 14 MW WTGs are used.[22]
- Design and visibility of lighting on the WTG nacelle and potential mitigation options to reduce light pollution (Appendix D). The greatest nighttime visual impact results from the aviation obstruction lighting requirement of two red flashing lights per WTG nacelle, plus an additional mid-tower light for structures taller than 699 feet (213 meters).
- Arrangement of WTGs and accessibility of WDA to recreational boaters. The WTG layout for Alternative A would consist of a grid-like pattern with an average spacing of 0.86 nautical mile between WTGs with corridors in a northwest/southeast and northeast/southwest direction. Alternatives C through F propose different spacing and patterns.[23]
- The time of year during which onshore and near shore construction occurs. Tourism and recreational activities in the study area tend to be higher from May through September, and especially from June through August.
- Increasing the size of the proposed substation by 2.2 acres (less than 0.1 km^2), as described in Chapter 2, would not change the analysis of impacts on recreation and tourism for Alternative A and all other action alternatives because the expanded substation area would be within a designated industrial area (Section A.8.6.2).

Alternative A alone would have long-term, **minor** impacts on recreation and tourism in the geographic analysis area due to the visual impact of the 57 WTGs from coastal locations and the greater navigational risks for recreational

[22] Although Vineyard Wind proposes 106 WTG placement locations as part of the PDE, no more than 100 total WTGs would be installed as part of the proposed Project.
[23] The 0.76 to 1 nautical mile spacing is the typical grid spacing proposed, with an average spacing between WTGs of 0.86 nautical mile. Section 2.1.1.1 provides more detail.

vessels within the WDA. It would also have long-term, **minor beneficial** impacts due to the fish aggregation and habitat conversion impacts of the WTGs and ESPs, resulting in new fishing and sightseeing opportunities. Alternative A 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.

The reasonably foreseeable environmental trends and planned action impacts of Alternative A in addition to ongoing activities, future non-offshore wind activities, and future offshore wind activities are listed by IPF in Table 3.9-1. The most impactful beneficial IPFs would include the presence of future offshore wind structures that could attract fish, invertebrates, and marine mammals, while the most impactful IPFs would include temporary construction noise and the presence of offshore structures.

Anchoring: Anchoring by Proposed Action construction and maintenance vessels would contribute to disturbance of marine species and inconvenience to recreational vessels that must navigate around the anchored vessels. The Proposed Action would deploy four to six vessels along sections of the OECC during cable installation activities (COP Volume III, Section 7.8.2.1.2 and Appendix III-I; Epsilon 2020b). During the construction phase, an average of 25 vessels (up to 46 vessels during the period of maximum activity) would be present in the WDA or OECC at any one time. Some anchored vessels within 12 nautical miles of the coast could be within a temporary safety zone established by the USCG (Section 3.11.2).

Vessel anchoring for construction of Alternative A alone 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 3.3). In context of reasonably foreseeable environmental trends, combined anchoring impacts on recreational boating from ongoing and planned actions, including Alternative A, would likely have localized, short-term, **minor** to **moderate** impacts on recreation and tourism 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 RI and MA Lease Areas, potentially resulting in **moderate** impacts.

Light: When nighttime construction occurs, the vessel lighting for vessels traveling to and working at the proposed Project'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. Work lights are generally directed downward, and would not typically be visible from shore (COP Volume III, Appendix III-H.a; Epsilon 2020d). Nevertheless, some nighttime lighting would be visible from southern coastlines.

During operations, Alternative A would have a discrete contribution to nighttime visibility of the WTGs due to required aviation hazard lighting. Hazard lighting from all of Alternative A's WTGs could be visible up to 35 miles (56 kilometers) away from some south-facing coastlines and elevated locations on Martha's Vineyard, Nantucket, and possibly Cape Cod, depending on vegetation, topography, weather, and atmospheric conditions. Comments on the DEIS indicated a concern about the potential for aviation obstruction lighting to affect the area's "astronomical heritage"—the social values and history related to the ability to observe stars and planets at night. These comments specifically requested the use of an ADLS to mitigate these impacts. Vineyard Wind has committed to voluntarily implement ADLS (as described in Appendix D) as a voluntary measure that would activate the Proposed Action's WTG lighting only when aircraft approach the Vineyard Wind 1 Project WTGs, which is expected to occur less than 0.1 percent of annual nighttime hours. During other times (and during ADLS activation in weather or atmospheric conditions when WTG lighting is not visible from shore), the warning lighting would not be visible, and would thus not impact recreation and tourism. As noted in Section 3.9.1.1, during times when Alternative A'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 Alternative A's WTGs from shore, visible aviation hazard lighting for Alternative A would result in a long-term, intermittent, **negligible** impact on recreation and tourism.

Future offshore wind projects could cause aviation hazard lighting from 652 additional WTGs (709 total WTGs, including Alternative A [of the 775 WTGs within the analysis area]) to be potentially visible within the geographic analysis area. As described in Section 3.9.1.1, without use of ADLS, lighting from future offshore wind projects other than Alternative A would include red flashing lights on top of WTG nacelles and at the midpoint of WTG towers. In context of reasonably foreseeable environmental trends, combined lighting impacts on recreation and tourism from ongoing and planned actions, including Alternative A, would likely have a long-term, minor impact on recreation and tourism. This impact would be reduced to **negligible** magnitude if ADLS is implemented on all other offshore wind projects.

New cable emplacement and maintenance: Alternative A would have a discrete contribution to offshore cable emplacement due to the location of the OECC across Nantucket Sound. Installation of offshore cables would temporarily restrict access to the OECC route. An average of four cable-laying, support, and crew vessels and a maximum of six vessels may be deployed along sections of the OECC during construction and installation activities (COP Volume III, Section 7.8.2.1.2 and Appendix III-I; Epsilon 2020b). 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, requiring a vessel to remain at the same location for several days (COP Volume I, Section 4.2.3.3; Epsilon 2020a). Recreational vessels traveling near the route of the OECC would need to navigate around vessels and access-restricted areas associated with OECC installation. In addition, the routes for commercial ferry services operating out of Hyannis, Martha's Vineyard, and Nantucket cross the planned OECC route. Hy-Line Cruises does not anticipate disruptive impacts on their ferry routes during the cable-laying process, but they requested frequent Notices To Mariners and routine radio communication as OECC construction plans are finalized (COP Volume III, Appendix III-I; Epsilon 2020b). Communication with recreational fishing interests and ferry operators are addressed by the navigation-related mitigations listed in Section 3.11.2 and Appendix D. 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 mammals of interest for recreational fishing and sightseeing through dredging and turbulence, although species would recover upon completion (Sections 3.5.2 and 3.11.2), resulting in localized, short-term, **minor** impacts on recreation and tourism.

Onshore construction and installation would affect recreation and tourism at the landfall site. The landfall site at Covell's Beach would experience disturbance during installation of the cable onshore/offshore transition vaults, and during HDD or trenching in preparation for joining the onshore and offshore cables. Construction would prevent the use of part of the beach parking lot, and discourage beach visitation due to noise and activity. These impacts would be unavoidable during construction, but would be temporary, and would avoid the summer peak tourism season. Vineyard Wind would not perform activities at the landfall site during the months of June through September, unless authorized by the host town. Onshore construction would have temporary, localized, **moderate** impacts on recreation and tourism at the landfall site. As part of the HCA with the Town of Barnstable, Vineyard Wind would provide funds to the town for reconstruction of a bathhouse at Covell's Beach (Town of Barnstable 2018), providing a localized **minor beneficial** impact for recreation.

Specific cable locations associated with future offshore wind projects have not been identified within the geographic analysis area with the exception of the Vineyard Wind 2 Project cable, which would use the same offshore cable corridor as the Proposed Action. The Equinor, Mayflower, and Bay State Wind offshore wind project cables would cross the geographic analysis area. Based on the assumptions in Appendix A, cables would not be installed concurrently with the Proposed Action, except for the South Fork Wind project. The extended period of time during which cables would be installed within the geographic analysis area and the temporal overlap of the Proposed Action with the South Fork Wind project would influence the extent of impacts from this IPF. In context of reasonably foreseeable environmental trends, combined impacts of cable emplacement and maintenance on recreational marine activities from ongoing and planned actions, including Alternative A, would likely be short-term and **minor** to **moderate**.

Noise: Noise from operations and maintenance, pile driving and trenching, and vessels could result in impacts on recreation and tourism.

Temporary impacts on recreation and tourism would result from the impact within the WDA and along the OECC route on species important to recreational fishing and sightseeing. The temporary disruptions to or changes in offshore fish, shellfish, and whale populations (Sections 3.3 and 3.4) would have a **moderate** impact on recreational fishing, shellfishing, or whale-watching activities, although whale-watching voyages typically travel north of Cape Cod, away from the WDA.

In addition to the temporary disruption to fish, shellfish and whale populations, offshore construction and onshore cable installation near the landfall area would have impacts on the recreational enjoyment of the marine and coastal environments, with **minor** impacts on recreation and tourism. Covell's Beach and nearby areas would experience noise during construction. Offshore construction noise would occur from vessels, trenching and pile driving along the OECC and within the WDA. Noise from pile driving, the noisiest aspect of WTG installation, is estimated to be 60 dB on the A-weighted scale at a distance of 1 nautical mile from the construction zone (COP Volume III, Appendix III-I, Section 7.5.1.1; Epsilon 2020b), comparable to the noise level of a normal conversation (OSHA 2011). Pile driving would occur for approximately 2 to 3 hours per foundation or 4 to 6 hours per day for the installation of two foundations per day. Accordingly, even where areas within or near the OECC and WDA are available for recreational boating during construction, increased noise from construction would temporarily inconvenience recreational boaters.

Overall, construction noise from Alternative A 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 thus have continuous, long-term, **negligible** impacts.

As stated in Table A-6 in Appendix A, pile driving for the Revolution and Sunrise Wind projects would overlap Alternative A construction, and future offshore wind surveying and construction would generate successive periods of intermittent offshore noise, resulting in potential for noise generated by concurrent and successive activity within the geographic analysis area. In context of reasonably foreseeable environmental trends, combined noise impacts on marine recreation activities from ongoing and planned actions, including Alternative A, would likely be localized, short-term, and **minor** to **moderate** during construction, and long-term and **negligible** during operation.

Port utilization: The geographic analysis area for recreation and tourism contains no ports anticipated to be used for staging and construction support or operations support for offshore wind. Vineyard Wind plans to locate the Operations and Maintenance Facilities at Vineyard Haven Harbor, which supports a mix of recreational, ferry, and commercial fishing vessel activity. No public parks, beaches, or other public recreational facilities are immediately adjacent to the harbor. Alternative A alone would have a discrete impact on Vineyard Haven Harbor, but the increase in marine traffic within the harbor is not anticipated to affect recreational boating. The Proposed Action would have a long-term, **negligible**, impact on recreation and tourism due to port utilization within the geographic analysis area.

No other offshore wind projects are known to have plans to use Vineyard Haven Harbor for operational support, although such use is possible. Accordingly, in context of reasonably foreseeable environmental trends, combined port utilization impacts on recreation and tourism from ongoing and planned actions, including Alternative A, would have a long-term **negligible** impact.

Presence of structures: As noted at the beginning of this section, the maximum-case scenario for the presence of offshore structures is different for recreational boating and visual impacts. The 8 MW WTG option represents the maximum-case scenario for recreational boating, due to the need for 100 WTGs as compared to the 57 structures needed if 14 MW WTGs are used. The 14 MW WTG option represents the maximum-case scenario for visual impacts because the taller WTGs would be visible from more coastal locations than the smaller, 8 MW WTGs.

The Proposed Action's maximum impact on recreation-related boating would result from 100 WTGs and 2 ESPs. The offshore structures would impact 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 sailboat races, 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 within the WDA, anticipated to take place over a 1.5- to 2-year period, would impact recreational boaters, boat tours and charter boats (COP Volume I, Figure 1.5-1; Epsilon 2020a). Where established by USCG, Vineyard Wind would use a flexible, temporary safety zone around active construction areas within 12 nautical miles of the coast. Vineyard Wind would work with USCG to communicate these zones and other work areas to the boating public via Local Notices to Mariners (Section 3.11.2). Recreational boating activity within the WDA, approximately 36 miles (57.9 kilometers) from Hyannis and 15 miles (24.1 kilometers) from the south coast of Martha's Vineyard, is much less frequent than in areas closer to the coast (see Section 3.9.1). Vineyard Wind would mitigate impacts through the navigation-related mitigations listed in Section 3.11.2 and Appendix D. Long-distance sailing races occasionally traverse the WDA. These races typically occur every 2 to 4 years and could occur during construction within the WDA. Vineyard Wind would work with event organizers and the USCG in advance of these events (see Section 3.11.2) (COP Volume III, Appendix III-I, Section 8.2.2; Epsilon 2020b).

During operations and maintenance of the Proposed Action, the permanent presence of WTGs would create obstacles for recreational vessels. AIS transmissions found that recreational vessels ranging in size from 16 to 61 meters (52 to 200 feet) navigated within the WDA in 2016 and 2017, representing approximately 10 percent of all AIS vessel transmissions. In comparison, recreational vessels in Nantucket Sound accounted for 48 and 45 percent of all AIS transmissions in 2016 and 2017, respectively (COP Volume III, Appendix III-I: Epsilon 2020b). At their lowest point, WTG blades would be 89 feet (27 meters) above the surface. At this height, larger sailboats would need to navigate around the RSA, while smaller vessels could navigate unobstructed (except for the WTG monopiles). The AIS data from 2016 and 2017 also showed that two sailing vessels with a mast height greater than 89 feet (27 meters) traversed the WDA multiple times during these years (COP Volume III, Appendix III-I; Epsilon 2020b).

USCG anticipates no restrictions on fishing and navigating in the WDA during Project operation, although vessel operators would need to take the WTGs into account when setting courses through the WDA (CBI 2017). The USCG would need to adjust their 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 3.12.2.1. The USCG, BOEM, and the Bureau of Safety and Environmental Enforcement would continue to coordinate on SAR response exercises as has been done recently on the Coastal Virginia Offshore Wind Project.

Recreational anglers may avoid fishing in the WDA due to concerns about their ability to safely fish within or navigate through the area. For recreational anglers harvesting HMS such as tunas, sharks, and billfish, the spacing of the WTGs could impact access to fishing locations. The fishing methods used and the size, strength, and swimming speed of these larger species requires significantly more space for fishing, compared to other species; as a result, the proposed separation between WTGs may be insufficient for this type of fishing. Anglers who do fish within the WDA would need to change their methods (i.e., they would not be able to allow their boats to drift and would need to correct course to avoid WTGs). The lease area occupied by Alternative A represents 1 to 5 percent of HMS trips in southern New England waters.

As noted in Section 3.10.2, the presence of structures is anticipated to result in minor to moderate impacts on for-hire fishing operations due to displacement, competition for fishing locations, potential gear loss, potential longer transit duration, and other impacts described in detail in Section 3.10.2. 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 3.10 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 impact on for-hire fishing would be **moderate** because these enterprises are more likely to be materially affected by displacement, competition for resources and longer transit times in a manner similar to commercial fishing businesses.

Although some recreational anglers would avoid the WDA, 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 magnitude of benefits to recreational fishing and sightseeing from the Vineyard Wind WTGs would be reduced due to the distance from shore (Starbuck and Lipsky 2013). 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 ESPs on navigation and fishing (especially HMS fishing), the potential reef effects of these structures, and the risks to anchoring and gear loss associated with scour or cable protection, Alternative A would have long-term, continuous, **minor beneficial** and **minor** impacts on recreation and tourism.

Structures from other planned offshore wind development would generate comparable types of impacts as Alternative A 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** impacts on recreational fishing, recreational sailing and boating, and for-hire recreational fishing, as well as **minor beneficial** impacts. An additional impact could result from the layout of Alternative A's WTGs, which would differ from the predominant orientation of other offshore wind projects within the RI and MA Lease Areas in both spacing (less than 1 x 1 nautical miles) and orientation (rows of WTGs not oriented east-west and north-south). As described in Section 3.11.2, this disparity in orientation would hinder SAR activities, with potential safety impacts for recreational vessels, resulting in potentially **major** impacts on recreational boating. In context of reasonably foreseeable environmental trends, combined impacts of offshore structures from ongoing and planned actions, including Alternative A, would include **minor** to **major** impacts on marine recreational activities due to the increased number of offshore structures and reduction of SAR capacity, and **minor beneficial** impacts due to the opportunity for fishing and sightseeing provided by WTGs.

As it relates to visual impacts of presence of structures, Alternative A's WTGs would also affect recreation and tourism through visual impacts.

During construction, viewers on coastal Nantucket, Martha's Vineyard, and the nearby smaller islands 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 Alternative A would have a temporary **negligible** impact on recreation and tourism.

The WTGs would be in open ocean approximately 14.7 miles (23.7 kilometers) south of Martha's Vineyard and 14.1 miles (22.7 kilometers) from the closest coastline on Tuckernuck Island (part of the Nantucket National Historic Landmark). The maximum case 14 MW WTGs have a height of 837 feet (255 meters) and the top of the nacelle, where aviation warning lights are located, are positioned at a height of 495 feet (150.9 meters). 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 38.4 miles (62 kilometers). Between 38.4 miles and 30.3 miles (62 kilometers and 49 kilometers), only the WTG blades would be potentially visible above the horizon from the perspective of a beach-elevation viewer. Vineyard Wind has voluntarily committed to use ADLS and non-reflective pure white (RAL Number 9010) or light grey (RAL Number 7035) paint color as described in Appendix D to reduce impacts.

The geographic study area for visual impacts in the FEIS (Appendix A, Figure A.7-10) is bound by an outer limit of 38.4 miles (33.4 nautical miles, 61.9 kilometers) from the borders of the WDA, based on maximum theoretical blade tip visibility for a 14 MW WTG for a viewer at sea level. Beyond this distance, the entire 837-foot WTG would be obscured by the curvature of the earth for a viewer at sea level (Epsilon 2020d). Actual visibility would be limited to shorter distances due primarily to atmospheric and weather conditions, but also by factors such as air quality, sea spray, and waves. Even when visibility conditions are favorable, WTGs may not be noticeable to a casual observer due to low contrast, depending on distance, lighting, viewing angle, weather conditions, and limits to human visual acuity. Vineyard Wind conducted a GIS-based viewshed analysis to identify locations on the land where there is a relatively high probability that at least part of the proposed Project would be visible. The analysis was conducted to identify locations from which WTGs are theoretically visible during the daytime (based on the maximum WTG heights for each project), or nighttime (based on the height of FAA-required lighting installed at the top of the nacelle). The GIS-based viewshed incorporated the screening effects of vegetation, structures, and topography through use of Light Detection and Ranging (LIDAR) and topographic data but does not account for weather conditions, air quality, sea spray, waves, and other obscuring factors. GIS viewsheds created for the proposed Project are provided in Addendum 1 of Vineyard Wind's Visual Impact Assessment (COP Volume III, Appendix III-H.a; Epsilon 2020d).[24]

[24] These figures are available at https://www.boem.gov/vineyard-wind-cumulative-visual-assessment

The viewshed analysis indicates that visual impacts of offshore WTGs would be limited to the immediate shoreline of the Massachusetts mainland; the southern coastline and some elevated locations on Nantucket and Martha's Vineyard (COP Volume III, Appendix III-H.a, Figures 4 and 5; Epsilon 2020d); and shorelines facing the WDA on Cuttyhunk Island, Nomans Island, Muskeget Island, and Tuckernuck Island.

As described in Section 3.9.1.1, the southern shores of Martha's Vineyard and Nantucket located within the viewshed of the WTGs are sparsely developed but highly visited. When visible (i.e., on clear days in locations with unobstructed ocean views), Alternative A's 57, 14 MW WTGs (the tallest WTGs considered for Alternative A) 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. The primary impacts on visual resources would occur due to the contrast between the existing unobstructed sea views and the industrial-appearing WTGs to be constructed under Alternative A. The color and irregular forms of the WTGs would contrast with the uninterrupted horizontal horizon line associated with the open ocean. In locations that are highly sensitive to such contrast (such as undeveloped beach areas with no visible signs of human activity), impacts of Alternative A on visual resources alone could range from **minor** to **moderate**, depending on sun angle, atmospheric conditions and how many WTGs are discernable on any given day.

The proposed Project's effects on nonmarket values would also vary. Nonmarket values "reflect the benefits individuals attribute to experiences of the environment, uses of natural resources, or the existence of particular…conditions that do not involve market transactions and therefore lack prices" (BLM 2013). In the context of the proposed Project, nonmarket values could include perceptions of visual resources that are not reflected in economic outcomes, or the social and cultural values associated with healthy commercial or recreational fishing or boating industries. Nonmarket values are inherently subjective, and would vary from person to person. The studies cited in the discussion of visual impacts in Section 3.9.1 address nonmarket values associated with visual resources.

The visual impact of future offshore wind structures could impact 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. 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 3.9.1.1. Under the 14 MW scenario, nearly all coastal public viewpoints would be more than 15 miles (24.1 kilometers) from the closest WTGs. Research described in Section 3.9.1.1 suggests that at a distance of 15 miles (24.1 kilometers), only 6 percent of beach visitors would select a different beach based on the presence of future offshore wind turbines. As many as 10 of Alternative A's 57 WTGs (under the maximum-case scenario for visual impacts) would be within 15 miles (24.1 kilometers) of the coast of Martha's Vineyard, while 15 would be within 15 miles (24.1 kilometers) of the coast of Nantucket. Considering these factors, BOEM expects the impact of visible WTGs on the use and enjoyment of recreation and tourist facilities and activities during operations and maintenance of Alternative A to be long-term, continuous, and **minor**. While some visitors to south-facing coastal or elevated locations may alter their behavior, this changed behavior is unlikely to meaningfully affect the recreation and tourism industry as a whole (Section 3.6.2), primarily because coastlines and inland areas with no views of WTGs would not experience visual impacts. In addition, beaches with views of WTGs would also gain trips from the estimated 2.5 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 (Parsons and Firestone 2018).

Portions of 775 WTGs from Alternative A combined with future offshore wind projects could potentially be visible from coastal and elevated locations in the geographic analysis area, including up to 34 (fewer than 5 percent of the total) that would be within 15 miles (24.1 kilometers) of shore. The simulations prepared by Vineyard Wind show anticipated views in clear conditions of future offshore wind projects associated with the No Action Alternative combined with Alternative A at two locations on Martha's Vineyard (Aquinnah Cultural Center, and South Beach) and one location on Nantucket (Madaket Beach) (COP Volume III, Appendix III-H.a; Epsilon 2020d).[25] As shown, 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 Alternative A

[25] These figures are photosimulations prepared by Vineyard Wind, and are available at https://www.boem.gov/vineyard-wind-cumulative-visual-assessment

WTGs would contribute approximately equally to visual impacts from South Beach and Madaket Beach, locations where the Alternative A WTGs are closest to that particular viewpoint. Alternative A would be visually subordinate to future offshore wind projects from the Aquinnah Cultural Center due to distance and topographic screening. Atmospheric conditions would limit the number of WTGs discernable during daylight hours for a significant portion of the year (COP Volume III, Appendix III-H.b, Section 3.2; Epsilon 2020d). In context of reasonably foreseeable environmental trends, the combined visual impacts on recreation and tourism from ongoing and planned actions, including Alternative A, would likely have continuous long-term **minor** impacts in the overall geographic analysis area, with **moderate** impacts on south-facing shoreline areas of Martha's Vineyard, Nantucket and Cape Cod with views of WTGs. Impacts would be reduced when atmospheric conditions limit the number of WTGs discernable from any one viewing location.

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. The Proposed Action would generate an average of 7 daily vessel trips during the entire construction period and during peak construction periods would generate an average of 18 daily vessel trips to and from ports in Massachusetts, Rhode Island, and other locations. Construction would result in an average of 25 and a maximum of 46 vessels present at offshore work areas (COP Volume III, Appendix III-I, Section 5.2.2; Epsilon 2020b). Recreational vessels may experience delays within the ports serving the 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 OECC could potentially experience **minor** impacts.

For regularly scheduled maintenance and inspections, Vineyard Wind anticipates that, on average, one crew transfer vessel or survey/inspection vessel would operate in the WDA per day. In other maintenance or repair scenarios, additional vessels may be required, which could result in a maximum of three to four vessels per day operating within the WDA. This vessel traffic at Vineyard Haven Harbor would be consistent with the harbor's working seaport character and would not affect ongoing recreational use. The Operations and Maintenance Facilities at Vineyard Haven would be an indoor monitoring facility, consisting of office, warehouse, and dock space, and would be indistinguishable from other industrial or commercial businesses and maritime activities near or in the harbor. Operations and maintenance of Alternative A would therefore have **negligible** impacts on onshore recreation and tourism.

Impacts during decommissioning would be similar to the impacts during construction and installation. Temporary disruptions of marine traffic would occur in the immediate vicinity of the WDA while Vineyard Wind disassembles and ships WTGs to ports for further disposal. Removal of the OECC, if required, would also generate temporary disruptions of marine traffic. As with construction, decommissioning activities would have larger impacts if conducted during the summer season. Provided that Vineyard Wind uses the same navigation-related mitigations for decommissioning as proposed for the construction and installation process (Section 3.11 and Appendix D), decommissioning of Alternative A would have **minor** impacts on recreation and tourism.

Section 2.3 describes the non-routine activities associated with Alternative A. Activities requiring repair of WTGs, equipment or cables, or spills from maintenance or repair vessels would generally require intense, temporary activity to address emergency conditions or respond to an oil spill (COP Volume I, Appendix I-A; Epsilon 2020a). The unexpectedly frequent vessel activity in Vineyard Haven Harbor, and in offshore locations above the OECC or near individual WTGs, could temporarily prevent or deter recreation or tourist activities near the site of a given non-routine event. With implementation of the navigation-related mitigations listed in Section 3.11.2 and Appendix D, the impacts of non-routine activities on recreation and tourism would be **minor**.

The Proposed Action is anticipated to be under construction concurrently with two other projects (Revolution Wind and Sunrise Wind). Construction of these two offshore wind projects would increase the traffic generated between the ports and the RI and MA Lease Areas or cable installation 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 3.11.1).

In context of reasonably foreseeable environmental trends, combined vessel traffic impacts on recreation and tourism from ongoing and planned actions, including Alternative A, would be short-term, variable and **minor** during construction and long-term, intermittent, localized, and **negligible** during operations.

In summary, the impacts resulting from individual IPFs associated with Alternative A alone would range from **negligible** to **moderate** impacts and **negligible** to **minor beneficial** impacts. Impacts would result from short-term impacts during construction: noise, anchored vessels, and hindrances to navigation from the installation of the OECC and WTGs; and the long-term presence of cable hard cover and structures in the offshore wind energy area during operations, with resulting impacts on recreational vessel navigation and visual quality. Beneficial impacts would result from the reef affect and sightseeing attraction of offshore wind energy structures. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.9.1.2.

Considering all the IPFs together, BOEM anticipates that in the context of reasonably foreseeable environmental trends, combined impacts on recreation and tourism from ongoing and planned actions, including Alternative A, would be **moderate** and **minor beneficial**. The main drivers for the impact ratings include the long-term, **minor** to **major** impacts and **minor beneficial** impacts associated with the presence of offshore structures and cable hard cover. While long-term impacts are the main drivers, the overall moderate impacts are also indicated by the short-term, minor to moderate impacts during construction from anchoring, cable emplacement, noise, and vessel traffic. Moderate impacts include both impacts on marine recreational activities and impacts on recreation and tourism in portions of the geographic analysis area resulting from the visual impact of WTGs. The **minor beneficial** impacts would result from a small and measurable benefit from the opportunities provided by future offshore wind structures for tours and recreational fishing.

3.9.3. Consequences of Alternatives C, D1, D2, and E

The impacts of Alternatives C, D1, D2, and E on recreation and tourism are summarized below:

- Alternative C would relocate the six northernmost WTG locations to the southern portion of the WDA, providing more unobstructed space for navigation in the northern portion of the WDA, closer to ports and other shore facilities commonly used by recreational vessels. Moving WTGs away from the northern portion of the WDA would also reduce visual impacts on land-based recreation areas by moving the closest WTGs beyond 15 miles (24.1 kilometers) from the closest shore-based viewers, and reducing the portion of the proposed Project's WTGs that could be visible to land-based observers. In other respects, the impacts of Alternative C on recreation and tourism would be the same as those of Alternative A.
- Alternative D (including Alternatives D1 and D2) would result in different WTG configurations, establish wider spacing of WTGs, and require a larger WDA. The wider spacing would improve maneuverability for recreational vessels, and the grid pattern of Alternatives D1 and D2 would allow for easier course plotting through the WDA. Alternative D2 would align the proposed Project's WTGs in the same orientation as other reasonably foreseeable offshore wind projects in the RI and MA Lease Areas with regard to both spacing (less than 1 x 1 nautical miles) and orientation (rows of WTGs not oriented east-west and north-south). The resulting coordinated alignment and spacing, in the context of other offshore wind projects, would reduce the navigational safety impact for Alternative D2, in the context of other reasonably foreseeable offshore wind projects, from **major** to **moderate**. However, the larger overall WDA would increase the marine area affected by future offshore wind structures. On balance, Alternatives D1 and D2 would enhance navigation through the WDA but would remain similar in overall impact on recreation and tourism.
- Alternative E would involve construction of 84 WTGs, each with generation capacity of 9 to 10 MW. Alternative E would result in fewer structures and wider spacing between structures and/or a potentially smaller footprint for the WDA compared to the 100-turbine scenario for Alternative A. Conversely, Alternative E would require more offshore structures than the 57-turbine scenario for Alternative A (if 14 MW turbines are used). Generally, fewer turbines would decrease the impacts on offshore recreation activity compared to the proposed Project, but Alternative E would not change the overall impact magnitudes described for Alternative A. Overall, Alternative E would have impacts on recreation and tourism similar to those for Alternative A.

Accordingly, the impacts resulting from individual IPFs associated with Alternatives C, D1, D2, and E alone on recreation and tourism would be similar to those of Alternative A alone: **negligible** to **moderate** impacts due to the IPFs discussed above, and **negligible** to **minor beneficial** impacts (due to new offshore recreational opportunities).

In context of reasonably foreseeable environmental trends, the combined impacts from ongoing and planned action, including Alternatives C, D1, or E, would be similar to Alternative A, with individual IPFs resulting in **negligible** to **major** impacts on recreation and tourism. Alternative D2 combined with ongoing and planned activities would have impacts from individual IPFs ranging from **negligible** to **moderate**, due to the reduced navigation and safety impact. Alternatives C, D1, D2 and E combined with ongoing and planned activities would all have **negligible** to **minor beneficial** impacts, the same as Alternative A, due to opportunities for new recreation activity. For any alternative, the majority of the impacts come from future offshore wind projects, and the incremental impacts of each alternative would be similar to those of Alternative A.

Overall, the combined impact on recreation and tourism from ongoing and planned actions, including each alternative, would be of the same level as Alternative A–**moderate** and **minor** beneficial. The impact rating is driven primarily by impacts from the long-term presence of offshore structures and short-term anchoring, cable emplacement, noise, and vessel traffic.

3.9.4. Consequences of Alternative F

Alternative F analyzes a vessel transit lane through the WDA, in which no surface occupancy would occur. BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. Under this alternative, BOEM is analyzing a 2- and 4-nautical-mile northwest/southeast vessel transit lane through the WDA combined with any action alternative; however, this analysis focuses on the combination of Alternative F with either Alternative A or Alternative D2 layout.

For Alternative A, a 2-nautical-mile transit lane would result in relocation of 16 WTG placements further away from shore and a 12 percent increase in the acreage of the WDA throughout which Project components would be distributed. A 4-nautical-mile transit lane would result in relocation of 34 WTGs further away from shore and a 25 percent increase in the acreage of the WDA.

For Alternative D2, a 2-nautical-mile transit lane would result in relocation of 16 WTG placements further away from shore. Alternative D2, in combination with the transit lane, would increase WDA acreage by about 41 percent. A 4-nautical-mile transit lane added to Alternative D2 would result in relocation of 33 WTGs further away from shore. Alternative D2 in combination with the transit lane would increase the WDA acreage by about 61 percent.

The impacts of Alternative F on recreation and tourism would be similar to Alternative A. Alternative F would increase both the adverse and beneficial impacts on recreation and tourism as itemized below.

- The transit lane could benefit some recreational vessels in travelling through the WDA; however, the transit lane direction is oriented to assist common commercial fishing transit routes and its orientation would not necessarily provide a useful route for all recreational vessels passing through the area. The transit lane itself may also be used for both recreational and commercial fishing, in addition to funneling traffic through the WDA. This funneling effect would increase the potential for allision, collision, and other navigation conflicts for recreational and other vessels. Because of the ease of navigating within the transit lane, recreational fishing vessels attracted by fish aggregation effects of the WTGs could flank the sides of the structures within the transit lane. Although there is some uncertainty about how traffic and anglers would behave, flanking these areas could lead to increased vessel congestion, space conflict, and navigational risk.
- Alternative F would increase the extent of the WDA as noted above. As described in Section 3.9.1, about 97 percent of recreational vessels stay within 3 miles (5 kilometers) of shore. Those that travel as far from shore as the Proposed Action, such as HMS fishing vessels, sailboat races, and sightseeing tours, would have a larger WDA to avoid or navigate through.
- Alternative F would increase inter-array cabling by up to 37 percent, requiring between 221 and 234 miles (355 and 376 kilometers) of inter-array cabling, depending on the width of the transit lane, number of WTGs,

and WTG arrangement within the WDA (Section 2.1.5). The inter-array cables would likely not require cable protection measures.

- Alternative F would marginally reduce the visual impacts of WTG structures and hazard lighting, because 16 to 34 WTGs would be farther from shore, reducing the number of WTGs and lights potentially visible from coastal locations. Due to the distance between the WDA and onshore viewers, these relocations would not change the visual impacts on recreation and tourism described for Alternative A.

The benefit of the transit lane to recreational vessels is balanced by the inconvenience resulting from a larger WDA and potential navigational conflicts resulting from use of the transit lane. The marginal reduction in visual impact would not change the overall minor visual impact on recreation and tourism. As a result, the impacts resulting from individual IPFs associated with Alternative F alone on recreation and tourism, regardless of underlying WTG layout would remain **negligible** to **moderate**, along with **negligible** to **minor beneficial** impacts due to new recreation activity.

When combined with Alternative D2, implementation of Alternative F would result in greater potential for allision, collision, and other navigation conflicts because the transit lane's northwest-southeast orientation would differ from the east-west orientation of Vineyard Wind 1 WTGs in Alternative D2, producing increased navigational complexity within the WDA. However, the impact level would not change, and impacts resulting from individual IPFs associated with Alternative F alone would be the same as for Alternative D2: **negligible** to **moderate** impacts due to the IPFs discussed above, and **negligible** to **minor beneficial** impacts due to new offshore recreational opportunities. BOEM has qualitatively evaluated the impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. To the extent additional transit lanes are implemented in the future outside the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located farther from shore, similar to the proposed Project under Alternative F. As a result, establishment of these additional transit lanes could require longer vessel trips for all phases of future projects and longer timeframes for cable installation. Collectively, a 2-nautical-mile or 4-nautical-mile transit lane would result in greater impacts on recreation and tourism overall than if Alternative F were not implemented, due to increased vessel congestion, space conflict, and navigational risk within and along the transit lanes and larger combined lease areas to navigate through. If the increased inter-array cabling requires additional hardcover, the transit lanes would also result in potential for increased anchoring limitations, gear entanglement, and loss due to increased hardcover area.

In context of reasonably foreseeable environmental trends, the combined impacts from ongoing and planned actions, including Alternative F in conjunction with either Alternative A or Alternative D2, would be very similar to those of Alternative A - **negligible** to **major** impacts on recreation and tourism, along with **negligible** to **minor** beneficial impacts due to new recreation activity. The majority of the impacts come from future offshore wind projects, and the incremental impacts of Alternative F would be similar to those of Alternative A. A northwest-southeast transit lane through the WDA would negate some of the increased navigational safety that would result from the east/west and north/south alignment of WTGs for Alternative D2, as described in Section 3.9.3.

Overall, the combined impact on recreation and tourism from ongoing and planned actions, including Alternative F, would be of the same level as Alternative A–**moderate** impact and **minor** beneficial. The impact rating is driven primarily by impacts from the long-term presence of offshore structures and short-term anchoring, cable emplacement, noise, and vessel traffic.

3.9.5. Comparison of Alternatives

As discussed above, the impacts on recreation and tourism associated with Alternative A alone do not change substantially in Alternatives C through E. All of the alternatives that incorporate WTGs with capacities between 8 and 10 MW would have a reduced adverse visual impact compared to the proposed 14 MW WTG option, due to shorter tower heights and less required lighting, but they would have a greater impact on recreational boating, due to the greater number of offshore structures necessary. The impacts of Alternative F alone, with either Alternative A or the Alternative D2 WTG layout, would also be similar to each other and to other action alternatives. Furthermore, the combined impacts on recreation and tourism from ongoing and planned actions, including Alternatives A, C, D1, E or F, would be similar while Alternative D2 would reduce the impact on navigational safety due to the adoption of spacing and orientation compatible with future adjacent wind projects. See Table 2.4-1 for a comparison of alternative impacts.

3.9.6. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. The Preferred Alternative incorporates the use of ADLS and non-reflective pure white (RAL Number 9010) or light grey (RAL Number 7035) paint color, as described in Appendix D. The Preferred Alternative would relocate the six northernmost WTG locations to the southern portion of the WDA. The relocation would provide unobstructed navigation in the northern portion of the WDA closer to shore and would reduce visual impacts by moving the closest WTGs beyond 15 miles (24.1 kilometers) from the closest shore-based viewers. The Preferred Alternative would also reduce the maximum possible number of WTGs for the proposed Project from 100 to no more than 84, reducing the impact of the WTGs and inter-array cables on recreational fishing, boating and sightseeing within the WDA. Finally, the Preferred alternative would align the proposed Project's WTGs in the same orientation as other reasonably foreseeable offshore wind projects in the RI and MA Lease Areas with regard to both spacing (less than 1 x 1 nautical miles) and orientation (rows of WTGs not oriented east-west and north-south). As described above, the resulting coordinated alignment and spacing, in the context of other offshore wind projects, would incrementally reduce the impacts on navigation from the IPF for the presence of offshore structures, although the impact magnitude would remain **moderate**. In all other aspects, construction and operation of the Preferred Alternative would be identical to Alternative A, with **moderate** impacts and **minor beneficial** impacts. This impact rating is primarily driven by the long-term presence of offshore structures and short-term anchoring, cable emplacement, noise, and vessel traffic.

3.10. Commercial Fisheries and For-Hire Recreational Fishing

3.10.1. No Action Alternative and Affected Environment

This section discusses existing commercial and for-hire recreational fishing in the geographic analysis area for commercial fisheries and for-hire recreational fishing as described in Table A-1 and shown on Figure A.7-10, Appendix A. Specifically, this includes the boundaries of the management area of the New England Fishery Management Council and of the Mid-Atlantic Fishery Management Council for all federal fisheries within the U.S. Exclusive Economic Zone (from 3 to 200 nautical miles from the coastline) through Cape Hatteras, North Carolina, plus state waters (from 0 to 3 nautical miles from the coastline). Table 3.10-1 describes baseline conditions and the impacts, based on the IPFs assessed, of ongoing and future offshore activities other than offshore wind, which is discussed below. Commercial fisheries refer to fishing activities that sell catch for profit, whereas for-hire fishing boats sell recreational fishing trips to anglers. Section 3.9 provides analysis of private recreational fishing impacts.

The fisheries resources in federal waters off New England provide a significant amount of revenue. New Bedford, Massachusetts, has consistently been the highest value-producing U.S. fishing port (NOAA 2018c). In 2018, commercial fisheries harvested more than 1.2 billion pounds of fish and shellfish in the North and Mid-Atlantic region, for a total landed value of over $1.8 billion; from 2009 to 2018, average annual landings were 1.3 billion pounds with a value of $1.6 billion (ACCSP 2018). From 2009 to 2018, the value of landings has ranged from $1.2 billion to over $1.8 billion, while landings weight has ranged from 1.16 billion pounds to 1.40 billion pounds. In Massachusetts, commercial fisheries harvested over 222 million pounds of fish and shellfish in 2018 for a total landed value of over $630 million.

Commercial fisheries in the northeast United States are known for the large landings of herring, menhaden, clam, squid, scallop, skate, and lobster, and for being a notable source of profit from scallop, lobster, clam, squid, and other species (NOAA 2019b). Figure 3.10-1 shows fishing revenue intensity in the region around the WDA; the fishing revenue is for all federally managed fisheries aggregated for the years 2007 to 2017 (G. DePiper, Pers. Comm., April 2019). Commercial fisheries obtained the greatest concentration of revenue from around the 164-foot (50-meter) contour off Long Island and Georges Bank. NMFS has excluded mobile gear fishing in parts of Georges Bank for fish stock rebuilding. Moderate revenue fishing areas (yellow on Figure 3.10-1) are apparent within and in the vicinity of the WDA. Chart plotter data submitted by commercial vessels targeting squid and whiting reflect fishing in these areas.

Over 4,300 federally permitted fishing vessels were in the Northeast in 2017, landing fish in several major Northeast ports (Table 3.10-2) (NOAA 2019d). In 2018, at the New Bedford port, commercial fishing landed more than 113.5 million pounds of products valued at $438.8 million (Table 3.10-2). Point Judith, Rhode Island, landed 47.5 million pounds in 2017, valued at $64.8 million. Table 3.10-2 lists the value and volume of landings of selected regional ports. The regional setting extends primarily over the fishing ports and waters in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey, although vessels from other ports may occasionally operate in the area. Commercial vessels active in the RI and MA Lease Areas may be homeported and/or land product in ports in those states. Other ports such as Nantucket are much smaller, but of importance to vessels homeported in those ports; however, for small ports, landing and fishing revenue data are often confidential because of the small number of fishing vessels involved. Unless noted otherwise, fishing revenue data in tables were converted to 2019 dollars using the quarterly, seasonally adjusted Gross Domestic Product Implicit Price Deflator provided by Federal Reserve Economic Data.

The commercial fishing fleets contribute to the overall economy in the region through direct employment, income, and gross revenues, as well as through products and services to maintain and operate vessels, seafood processors, wholesalers/distributors, and retailers. In 2015, commercial fisheries in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey created 61,865 jobs, generated $2,761 million in sales, and contributed $1,380 million in value added (gross domestic product; NOAA 2017a). In Massachusetts, of the 52,710 jobs created, commercial harvesters held 10,923 and retail created 39,323, with the remaining in seafood processing (1,509) and seafood wholesaling and distribution (955). Further, commercial harvesters received $302.5 million in income, retailers $369.6 million, seafood processors $83.1 million, and seafood wholesalers and distributors $55.2 million. In Rhode Island, of the 4,522 jobs created, 2,016 were held by commercial harvesters and 2,107 were created in retail, with the remaining in seafood processing (284) and seafood wholesaling and distribution (115); commercial harvesters generated $42.5 million in income (NOAA 2017a). See Section 3.6 for additional discussion of commercial fishing communities.

Input-output models can be used to estimate the economic impacts associated with the harvesting of fish by commercial fishermen and the seafood industry. A study conducted by the University of Rhode Island (undated) on the *Economic Impacts of the Rhode Island's Fisheries and Seafood Sector* investigated the contributions of commercial fishing, charters, processing, professional service firms, retail and wholesale seafood dealers, service and supply firms, and tackle shops to assess their contributions to the state and national economy. The study concluded that the Rhode Island seafood industry generated 3,147 jobs and $538.3 million in gross sales with the total spillover effect to other industries of 4,381 jobs and output of $419.8 million. The vessel landings job multiplier was estimated at 32.43 jobs per $1.0 million, while the vessels landings economic impact multiplier was estimated at 1.98 (value added basis).

The Vineyard Wind lease area is located in the Massachusetts Wind Energy Area,[26] with the WDA located in the northern part of the Vineyard Wind lease area (Figure 3.10-1). Value of port landings harvested from the Vineyard Wind lease area is shown in Table 3.10-3a and Table 3.10-3b. Table 3.10-3a was prepared by the Rhode Island Department of Environmental Management (RI DEM) using a Vessel Monitoring System (VMS) analysis to identify five landing ports that used the Vineyard Wind lease area (RI DEM 2017). VMS landings data were acquired for Rhode Island, New Hampshire, Massachusetts, New York, and New Jersey. The collected data covered a portion of the Atlantic Coast EEZ. VMS monitors the location and movement of commercial fishing vessels in the U.S. EEZ and treaty areas and helps to characterize the density of commercial fishing activity. The VMS program currently monitors more than 4,000 vessels; however, not all fisheries are required to use VMS. In addition, VMS data for the squid fishery was sparse in the early years of the dataset as VMS was only required for squid vessels starting in 2014, and did not have full coverage in 2017. In general, VMS as a source of location data underrepresents some fishing activity, as some fisheries, like lobster and Jonah crab, do not have VMS requirements. Therefore, revenue for non-represented fisheries in a particular area may be undervalued.

Table 3.10-3b was provided by the NOAA NEFSC. NOAA NEFSC used the federal Vessel Trip Report (VTR) to collect landings data. VTR data is collected by all NMFS permitted-vessels, regardless of where fishing occurs or

[26] The Massachusetts Wind Energy Area analyzed constitutes the Bay State Wind and Vineyard Wind leases, plus areas slated for lease sale at the time of this FEIS. It does not include the export cable route.

what species are targeted. The only federally permitted vessels not required to provide VTRs is the lobster fishery. Other non-federally permitted fisheries (e.g., Jonah crab and menhaden) also do not have a federal reporting requirement. To compile data shown in Table 3.10-3b, NOAA NEFSC queried VTR data for positional data and linked it to dealer data for value and landings information. However, it is acknowledged that VTR data may misrepresent the actual location where the fish were harvested on a given trip. Fishermen are required to record the haul back position where the majority of fishing occurred, and separate VTRs are required only when fishermen change statistical areas or gear. Consequently, a single location can be used to record multiple tows, and this may not be representative of where fishing actually occurred.

The RI DEM analysis (Table 3.10-3a) shows substantial variability in catch over time. Point Judith landings varied from just over $550,278 in 2011 to over $3.0 million in 2016, which coincides with a peak year for the squid industry that is primarily based in that port.[27] This information regarding the area's use as a fishery matches Point Judith- and Montauk-based vessel chart plotter data regarding the use of this area (Figure 3.10-19). Similar variability in catch, likely due to squid landings, is shown for New Bedford that had a landings revenue of $126,017 in 2011 and over $1.5 million in 2016. The RI DEM analysis identified the ports of New Bedford and Point Judith as having relatively higher value of landings from the Vineyard Wind lease area.

While VTR data compiled by the NOAA NEFSC also show substantial variability in the year-to-year revenue, it tells a different story (Table 3.10-3b). VTRs show that Point Judith landed a revenue of $1.5 million in 2016, compared to $3.2 million recorded by the VMS data (Table 3.10-3a). As another example, VMS data show a revenue of $872,311 in 2012 for Point Judith, compared to $88,828 compiled from VTRs. In general, the total landed value in 2016 using VTRs is estimated at $2.5 million, being substantially higher compared to the revenue landed in any other year in the investigated period (Table 3.10-3b). The differences in values with these two approaches are due to the different spatial data used (VTR point data versus VMS data) and the weighting done in the RI DEM analysis. Specifically, the RI DEM analysis took the raw fishing density maps by species caught to weight the value of fishing location points within each trip. Rather than assuming all fishing activity is equal, in order to scale the landings by the amount of fishing activity within each area per trip, each individual fishing point within a trip was weighted by the fishing density map for that fishery that year. Weighting the values based on fishing density places higher weights on points where the fishing density was higher. This strategy assumes that fishermen target the most profitable areas (i.e., where species abundances are higher) (RI DEM 2017). Together, these two approaches create a range of harvest revenue that occurred across the entire Vineyard Wind lease area.

Table 3.10-3a and Table 3.10-3b show how various data collection and analysis methods (VMS versus VTR) can provide varying estimates of the fishing activity in the Vineyard Wind lease area. More details about commercial fishing ports are available in COP Volume III, Section 7.6 (Epsilon 2020b).

The ports of Point Judith and New Bedford also support other economic activities through spending and job creation that depend on commercial and for-hire recreational fishing such as preparation and packaging of seafood, wholesale and retail seafood sales, purchase of fishing equipment, accommodation, and other goods and services related to commercial fishing.

Figure 3.10-2 shows the relative squid fishing vessel density during the year 2015 to 2016 using VMS, both with all recorded squid fishing vessels traveling at any speed, and speed filtered to show only those vessels traveling less than 4 knots. Figure 3.10-17 shows the total number of unique squid fishing vessels (92) and orientation of fishing direction (roughly east-west) between 2014 and 2019 across the entire RI and MA Lease Areas. As previously noted, VMS as a source of location data for the squid fishery may underrepresent fishing activity prior to 2017. Also, VMS data show vessel presence, but do not indicate whether the vessel is fishing or not. The presence of vessels traveling less than 4 knots may better indicate squid fishing activity because higher-speed vessels are more likely to be transiting.

NOAA NEFSC also identified that more than $280,000[28] of lobster pot gear revenue comes from within the Massachusetts Wind Energy Area, which is primarily landed in Massachusetts (Kirkpatrick et al. 2017). After scallops, the state's second most valuable fishery is lobster, which has annual average landings of approximately

[27] VMS was not required until 2014 for squid vessels.

[28] Based on 2007 to 2012 data and stated in 2015 dollars.

$61 million. Much of the southern New England lobster fleet has transitioned to a mixed crustacean fishery targeting both Jonah crabs and lobsters (ASMFC 2018b). Comments during scoping for the EIS indicated that a majority of lobster effort is south and west of the proposed Project area (Figure 3.10-3). However, lobster pot landings may be underestimated due to incomplete reporting for trap vessels that are not subject to mandatory reporting.

BOEM analyzed an expanded data set including two additional years (G. DePiper, Pers. Comm., 2018) that is isolated to federally permitted commercial fishing activity within the WDA.[29] Figure 3.10-4 shows that commercial fisheries harvested $3.67 million in revenue in the Atlantic Mackerel, Squid, and Butterfish FMP and Atlantic Surfclam and Ocean Quahog FMP over a 12-year period. Looking at the value of catch within the WDA for each FMP as a percentage of the total revenue for each FMP in the region, the largest absolute shares occur in the Northeast Multispecies FMP (small mesh) and the Atlantic Mackerel, Squid, and Butterfish FMP, but in each case, less than 0.5 percent of the FMP's total revenue is harvested within the WDA.

Table 3.10-4a and Table 3.10-4b show the annual value of landings (2019 dollars) for the top seven FMPs in the WDA during 2007 to 2018. There has been substantial variability in the year-to-year harvest of various species in the WDA. NOAA NEFSC provided additional data on the value and volume of fishing in the WDA. The data are based on the VTRs; value of fishing is provided in 2019 dollars by species, gear, port, and state, while volume landed is provided in pounds (Table 3.10-5a through Table 3.10-8b). Although Table 3.10-4a, Table 3.10-4b, and Table 3.10-5a through Table 3.10-8b are based on the same underlying VTR data, Table 3.10-4a and Table 3.10-4b use a VTR mapping model developed by the NMFS NEFSC. The VTR mapping model allows for a more conservative analysis using VTR data by taking into account some of the uncertainties around each reported point. Using observer data, for which precise locations are available, the model was developed to derive probability distributions for actual fishing locations around a provided VTR point. Other variables likely to impact the precision of a given VTR point, such as trip length, vessel size, and fishery, were also incorporated into the model. This model allows for generating maps that predict the spatial footprint of fishing. In this case, the modeled data indicate greater revenue exposure than that indicated by the VTR reported position alone over the same period.

Analysis prepared by the RI DEM for the WDA, using VMS and VTR data, provides an estimate of the ex-vessel value (the price received at port of landing) of the Rhode Island commercial fishing industry that is derived from the WDA (RI DEM 2019). The study suggests that the value of fishing in the area is $35.6 million for a 30-year period (corresponding to the length of the lease and construction time). The values are premised on existing trips that either fully or partially intersect the WDA area, including a 2-nautical-mile section north or south of the WDA area. The study further showed that almost $21 million of the total 30-year value would be from the Atlantic Mackerel, Squid, and Butterfish FMP; $4.7 million from the Northeast Multispecies FMP—small mesh species (hakes); $4.6 million from Summer Flounder, Scup, and Black Sea Bass FMP; $2.2 million from groundfish, $1.5 million from American lobster; $1 million from scallops; and the remaining from other species. Again, the RI DEM (2019) analysis was specific to vessels landing in Rhode Island ports.

The Summer Flounder, Scup, Black Sea Bass FMP landed up to 0.2 percent of the total coast-wide revenue (Table 3.10-4b). Between 2007 and 2018, annual revenue from landings of summer flounder, scup, and black sea bass in the WDA ranged from $4,045 to $96,519, with a total revenue of $560,360 for 2007 to 2018 (2019 dollars, Table 3.10-4a). Summer flounder is most often landed from January to September, with the peak in June through August. Three periods comprise the scup's quota. In spring and summer, scup migrate to northern and inshore waters to spawn. The black sea bass peak harvest is typically June through September.

Many potentially affected fisheries, including the whiting, summer flounder, scup, and black sea bass are not required to use VMS. Therefore, these fisheries are underrepresented in evaluations of impacts from the WDA or the cable corridor. Data from several sources are provided in this section to show how the estimates of catch from the WDA may differ depending on the measurement method.

Data provided by NOAA NEFSC (Table 3.10-5a and Table 3.10-5b) that were collected through VTRs show low revenue from the WDA for black sea bass ($10,257 for 2008 through 2017), and revenues for scup totaling $203,103 and for flounders totaling $230,212 for 2008 through 2017 (2019 dollars).

[29] The WDA encompasses 45.3 percent of the entire Vineyard Wind lease area and 10.2 percent of the Massachusetts Wind Energy Area.

The Atlantic Mackerel, Squid, Butterfish FMP covers longfin and illex squid, which make up the majority species landed in this FMP. Bottom and mid-water trawling account for most landings (ASMFC 2018a). As shown on Figure 3.10-2, density was variable in vessels targeting squid throughout the WDA with patches of medium-low to medium-high density, and an area of very high density along the OECC. Revenue from the Atlantic Mackerel, Squid, and Butterfish FMP from the WDA ranged from a low of $11,390 in 2007 to a high of $978,455 in 2016 (Table 3.10-4a). For 2007 to 2018, the total revenue for this FMP was $2.3 million (Table 3.10-4a). Based on VMS data and the RI DEM analysis, 2016 also was a high revenue year ($5.1 million for the entire lease area) and around the WDA (Table 3.10-3a), but with higher activity densities also seen north of the WDA (Figure 3.10-2).

To the contrary, Table 3.10-5a shows no revenue from Atlantic mackerel from the WDA ($13 for 2008 to 2017), $751,728 in revenue from squids, and $29,673 from butterfish. For the period of 2008 to 2017, the squid fishing revenue from Rhode Island is estimated at $192.1 million with 235.1 million pounds landed. In general, squid landings in Rhode Island represented 53 percent of total squid landings from the Atlantic and 54 percent of total squid revenue from the Atlantic (based on nominal revenue data for 2008 to 2017; NOAA 2019a). With $643,551 in squid revenue from the WDA from 2008 to 2017, it appears that the WDA accounts for 0.18 percent of squid revenue from the Atlantic (or 0.33 percent of squid revenue from Rhode Island).

As shown on Figure 3.10-5, VMS data indicate that surfclam/ocean quahog fishing vessels are not typically found within the WDA; however, along the OECC there were areas where very high density of catch were indicated. Figure 3.10-5 shows the relative surfclam/ocean quahog fishing vessel density during the year 2015 to 2016, with all recorded fishing vessels traveling at any speed, and speed-filtered to show only those vessels traveling less than 4 knots. Note that VMS data show vessel presence, but do not indicate whether the vessel is fishing or not. The presence of vessels traveling less than 4 knots may better indicate surfclam/ocean quahog fishing activity because higher-speed vessels are more likely to be transiting. Figure 3.10-18 shows a majority of the 24 unique vessels in the surfclam and ocean quahog fishery transiting in a northeast-southwest direction through the southern New England lease areas. Surfclams are harvested principally via hydraulic dredging. The harvest of surfclam and ocean quahog in the WDA provided a high value of landings prior to 2011; however, since the harvest has substantially decreased in the WDA, valued at only $17,278 in 2015, increasing to $112,401 in 2016 and down to $11,222 in 2017. From 2007 to 2018, the total revenue for this FMP was $1.3 million from the WDA (Table 3.10-4a).

Sea scallop (*Placopecten magellanicus*) vessels had medium-low or medium-low to medium-high VMS density in the WDA, and higher VMS density (up to high) along the OECC (Figure 3.10-6). Figure 3.10-6 shows the relative sea scallop fishing vessel density during the years 2015 to 2016, with all recorded fishing vessels traveling at any speed, and speed-filtered to show only those vessels traveling less than 5 knots. VMS data show vessel presence, but do not indicate whether the vessel is fishing or not. The presence of vessels traveling less than 5 knots may better indicate sea scallop fishing activity because higher-speed vessels are more likely to be transiting. Figure 3.10-16 shows a majority of the 418 unique vessels in the scallop fishery transiting in a northwest-southeast direction through the southern New England lease areas. Dredges are the primary fishing gear. Table 3.10-4a shows that the annual revenue for this FMP from the WDA ranged from $1,822 to $28,642, with $108,877 landed from 2007 to 2018. To compare, VTR data show $118,081 in revenue from scallops/shellfish from the WDA in 2013, less than $4,600 in 2008, 2014, and 2016, and no revenue in the remaining years (Table 3.10-5a).

VTR data inform that other important sources of revenue from the WDA from 2008 to 2017 were Jonah crab (totaling $135,448), hakes ($552,841), American lobster ($295,229), monkfish ($429,179), and skate ($274,905; Table 3.10-5a and Table 3.10-5b).

Table 3.10-6a and Table 3.10-6b show the value and volume of landings for the WDA for 2008 to 2017. Bottom trawl is the primary gear type used in the WDA, where an estimated 57 percent of all revenue from the WDA and more than 65 percent of landed fish was caught using bottom trawl. Bottom trawl targets bluefish, monkfish, summer flounder, winter flounder, silver hake (whiting), spiny dogfish, smooth dogfish, scup, and black sea bass. The nearshore bottom trawl fishery targets butterfish, bluefish, and other finfish species; the deeper water fisheries target bluefish, Atlantic mackerel, Loligo squid, black sea bass, and scup (NOAA 2019e). Other deployed gear types in the WDA include pot and sink gillnet. Pot targets crabs, lobsters, scup, and black sea bass. Sink gillnet targets species such as yellowtail flounder, winter flounder, witch flounder, windowpane flounder, spiny dogfish, monkfish, silver hake, red hake, white hake, skate, mackerel, and other.

Commercial fishing vessels homeported in Point Judith, Rhode Island, fish in the WDA most intensively. From 2008 to 2017, Point Judith fishing revenue from the WDA is estimated at $1.5 million with 1.4 million pounds of catch landed in the port (Table 3.10-7a and Table 3.10-7b). Most of Point Judith fishing revenue is from the sale of squid, lobster, summer flounder, sea scallop, scup, monkfish, silver hake, Jonah crab, and yellowtail flounder (NMFS 2018d). In fact, 53 percent of fishing revenue from the WDA is landed in Rhode Island, with 35 percent landed in Massachusetts, and the remaining landed in other states (Table 3.10-8a).

It is more challenging to quantitatively characterize fishing along the OECC because it is a linear feature. In addition, fewer impacts are expected along the OECC due to the relatively narrow area potentially disturbed. As shown on Figures 3.10-2, 3.10-5, and 3.10-6, the OECC intersects areas with high vessel density for fishermen targeting squid, surfclams/ocean quahogs, and sea scallops. In addition, as shown on Figure 3.10-7, part of the OECC within state waters intersects an area of “high commercial fishing effort and value” identified in the Massachusetts Ocean Management Plan (MA EEA 2015). There is also low, medium-low to medium-high vessel density along the OECC, whereas vessel density in the WDA is characterized as low (Figures 3.10-8 and 3.10-9).

The MA DMF Draft Environmental Impact Report indicates that the OECC would pass through areas of commercial and recreational fishing and habitat for a variety of invertebrate and finfish species, including channeled whelk, knobbed whelk, longfin squid, summer flounder, windowpane flounder, scup, surfclam, sea scallop, quahog, horseshoe crabs, and blue mussel (Epsilon 2018b).

Blue mussel and kelp aquaculture operations are also located within Horseshoe Shoals (a subtidal area of Nantucket Sound) (Epsilon 2018b). Existing aquaculture operations lie near the southern portion of Horseshoe Shoals, near the main channel of Nantucket Sound. However, this is more than 4 nautical miles from the OECC. The Project is not anticipated to impact leased aquaculture sites.

Fishing for whelk, often referred to locally as conch, is done from Horseshoe Shoals and other areas in Nantucket Sound. This fishery was valued at $4.8 million in 2016. Although this is a relatively new fishery that was not heavily exploited until the early 2010s, signs indicate that the stocks are vulnerable to overfishing and may already be overfished. This fishery operates entirely within state waters, with a plurality of the total catch taken from Nantucket Sound (Nelson et al. 2018). Again, because of the distance from the OECC, Project activities are not expected to impact this fishery.

The lobster fishery in Massachusetts is the most lucrative fishery harvested within the state’s waters, but it is now in a depleted condition (Dean 2010; MA DMF 2016a). Despite the reduced landings (17.6 million pounds in 2016), rising prices bolster the fishery’s value, which was more than $82 million in 2017 (MA DMF 2016a). Recently, there has been very little lobster catch from nearshore waters south of Cape Cod; therefore, most vessels from this area now venture far offshore to target lobster in deeper waters (Abel 2017; Dean 2010; MA DMF 2016a).

Horseshoe crab spawning areas are associated with Covell’s Beach and Great Island Beach (Epsilon 2018b). This fishery, while significant to the state, is patchy and variable from year to year. Most of the catch comes from Cape Cod Bay, Nantucket Sound and near the islands of Nantucket and Martha’s Vineyard (Burns 2018; Perry 2017). Surfclam habitat and patchy eelgrass beds also occur in waters offshore of Covell’s Beach. For-hire recreational fishing is also an important economic sector regionally with peak activity June through August (NOAA 2017c). Regionally in 2015, the industry created 2,232 jobs, generated $326 million in sales, and contributed $192 million in value added. The Marine Recreational Information Program data show that mackerels, cod, and striped bass were the most-caught species within the Massachusetts for-hire recreational fishery. Black sea bass, scup, striped bass, summer flounder, and tautog were the most-caught species within the Rhode Island for-hire recreational fishery (NOAA 2017b).

In 2018, there were 129,862 party- and charter-boat fishing trips out of Massachusetts and 42,558 out of Rhode Island. However, there is substantial variability year to year with as few as 95,000 trips in 2016 and as many as 224,249 trips in 2017 from Massachusetts. Based on the number of trips over the past 10 years, there are on average 188,916 party- and charter-boat fishing trips per year out of Massachusetts and 45,648 out of Rhode Island (NOAA 2020h). On average, party and charter boats account for 5 percent of all recreational effort onboard boats off the coast of Massachusetts and 4 percent off the coast of Rhode Island based upon the Fishery Effort Survey

(NOAA 2020h). NOAA estimated that 97 percent of the 2011 recreational effort from Massachusetts occurred within 3 nautical miles of shore (BOEM 2012b).

For hire-recreational fishing in the Atlantic provides opportunities for recreational fishing of highly migratory species such as tuna, billfish, swordfish, and sharks. Tuna and sharks are found in the WDA where they feed on squid, mackerel, and butterfish found in the area. Tuna and sharks are targeted in the WDA by for-hire fishing boats. Highly migratory species such as tuna and shark are relatively costly to pursue for private anglers, as they require large vessels.

Popular recreational fishing areas across the whole RI and MA Lease Areas include "The Dump," where recreational vessels harvest yellowfin tuna, albacore tuna, and mahi. Other nearby recreational fishing locations include "The Owl" and the "The Star." "Gordon's Gully" is the only named recreational fishing location within the WDA. "31 Fathom Hole" and the Northeast Corner of the Dump are wholly and partially in the Vineyard Wind lease area (see Salty Cape 2018 for relative locations; Figure 3.10-10). Species caught by recreational vessels in these areas include bluefin tuna, mako, thresher sharks, white marlin, and yellowfin tuna. Along the OECC, harvested species often include striped bass, bluefish, bonito, false albacore, and bluefin tuna, as well as summer flounder, black sea bass, and scup (COP Volume III, Section 7.6.5; Epsilon 2020b). In general, for-hire recreational fishing boats from the Massachusetts area most often catch cod, hake, striped bass, and mackerel (COP Volume III, Section 7.6.5; Epsilon 2020b).

Figure 3.10-11 shows areas of high recreational fishing (both for-hire and private angler recreational fishing) effort (i.e., number of trips and total catch) for highly migratory species throughout the southern New England region from 2002 to 2018 (Kneebone and Capizzano 2020). Based on the interpolation of trips and catch as reported in the Large Pelagics Intercept Survey, generally, the greatest amount of recreational fishing effort for highly migratory species occurred to the west of the RI and MA Lease Areas in the waters south and east of Montauk Point and Block Island. Within the RI and MA Lease Areas, a large amount of fishing effort for all highly migratory species occurred in "The Dump," "Coxes Ledge," "The Fingers," and "The Claw." Fifty-eight members of the Rhode Island Party and Charter Boat Association stated that they fish in the WDA area, particularly Gordon's Gully for tuna and shark. The Star, The Claw, and the inside fingers are also in proximity. The members are worried that once the Project is in place, shark and tuna would no longer be found there, which could be harmful for business. Tuna and sharks are found in the WDA because they feed on squid, mackerel, and butterfish. If those species are adversely affected, tuna and shark may also leave the WDA. Finding alternative fishing spots could be challenging, as it is uncertain where the species may relocate.

The highest density of recreational vessels is reported within Nantucket Sound and within 1 nautical mile of the coastline (COP Volume III, Appendix III-I, Section 4.2; Epsilon 2020b). Table 3.10-9 shows the average annual number of for-hire recreational boat trips by port group based on federally reported VTRs that come within 1 nautical mile of the Massachusetts Lease Areas. NOAA NEFSC found only about 0.2 percent of for-hire boat trips and 0.325 percent of for-hire boat trips from Massachusetts, New Hampshire, New York, and Rhode Island were near the Massachusetts Wind Energy Area (i.e., BOEM lease areas OCS-A 0500, OCS-A 0501, OCS-A 0520, OCS-A 0521, and OCS-A 0522) (Kirkpatrick et al. 2017). Also, on average, more for-hire recreational fishing trips to the Massachusetts Lease Areas originate from Montauk, New York, than any other port or state.

There is substantial variability in the volume and value landed of various species fished within the WDA. For example, as stated in Table 3.10-4a, surfclam/ocean quahog harvested from within the WDA was valued at $6,111 to $327,689, depending on the year. Similarly, Atlantic Mackerel, Squid, and Butterfish FMP from within the WDA varied from $11,390 to $978,455 per year. In general, based on catch data for the last decade, the total annual revenue from landings within the WDA usually varied from about $300,000 to $600,000, but peaked in 2016 at a high of $1.3 million. Year-to-year variation in available catch, fishing effort, as well as quotas set for commercial and recreational fisheries to protect stocks and prevent overfishing, introduce significant fluctuations in how much is landed every year from within the WDA, the Massachusetts Wind Energy Area, and other locations. As a result, it is challenging to predict what the commercial fishing revenue from specific fishing areas, such as the RI and MA Lease Areas, would look like going forward. However, the activity and value of fisheries in recent years as described in the previous sections are expected to be indicative of future conditions and trends.

Commercial fisheries and for-hire recreational fishing in the geographic analysis area are subject to pressure from ongoing activities, including regulated fishing effort, vessel traffic, and climate change. Fisheries management impacts commercial fisheries and for-hire recreational fishing in the region through management of sustainable fish stocks and measures to reduce impacts on important habitat and protected species. These management plans include measures such as fishing seasons, quotas, and closed areas, which constrain how the fisheries are able to operate and adapt to change. These management actions can reduce or increase the size of available landings to commercial and for-hire recreational fisheries. Reasonably foreseeable fishery management actions include measures to reduce the risk of interactions between fishing gear and the North Atlantic right whale by 60 percent (McCreary and Brooks 2019). This, along with Area 3 trap cap reductions, wo likely have considerable impact on fishing effort in the lobster and Jonah crab fisheries in the geographic analysis area. The Baseline Conditions section in Table 3.10-1 includes additional details on specific future fishery management actions that would impact commercial fisheries and for-hire recreational fishing.

Climate change is also predicted to affect Northeast fishery species (Hare et al. 2016), which will impact commercial and for-hire fisheries differently; some stocks may increase habitat and some may see habitat reduced, depending on the targeted species and the ability of fishing regulations to adapt. Changing environmental and ocean conditions (currents, water temperature, etc.), increased storm magnitude or frequency, and shoreline changes can impact fish distribution, populations, and availability to commercial and for-hire recreational fisheries. See Section 3.3 and Table 3.3-1 for impacts on fish. Impacts from other ongoing activities, including structures such as existing cables and pipelines, have been largely mitigated through burial of the infrastructure.

3.10.1.1. Future Offshore Wind Activities (without Proposed Action)

BOEM expects that future offshore wind development activities would affect commercial fisheries and for-hire recreational fishing through the following primary IPFs.

Anchoring: Anchoring could pose a localized (within a few hundred meters of anchored vessels), temporary (hours to days) navigational hazard to fishing vessels. In the expanded planned action scenario, there would be increased vessel anchoring during survey activities and during the construction and installation of offshore components as a result of future offshore wind activities over the next 10 years. However, the location and level of these impacts would depend on specific locations and duration of activity. As specified in Table A-4 in Appendix A, BOEM assumes that anchoring disturbance for each offshore wind project, other than the Proposed Action, would be equal to 0.10 acre per mile of offshore export cable. If future projects utilize dynamic positioning vessels, these effects could be less. Up to 276 acres (1.1 km^2) of seafloor could be disturbed out of the over 200 million acres within the geographic analysis area as a result of anchoring during construction activities over the next 10 years. In addition, there could be increased anchoring associated with the installation of met towers or buoys. Anchoring impacts on finfish, invertebrates, and EFH are discussed in Section 3.3.1.1, and impacts on navigation and vessel traffic are discussed in Section 3.11.1.1.

New cable emplacement and maintenance activities: This IPF could cause localized, short-term impacts including disrupting fishing activities during active installation and maintenance or periods during which the cable is exposed on the seabed prior to burial (if simultaneous lay and burial techniques are not used). Fishing vessels may not have access to impacted areas, which could lead to reduced revenue and/or increased conflict over other fishing grounds. Assuming future projects use installation procedures similar to those proposed in the Vineyard Wind COP, the duration (one day to several months) and extent (several meters to 500 meters during active procedures) of impacts would include temporary displacement of fishing vessels and disruption of fishing activities in the estimated total area of disturbance up to 8,153 acres (33 km^2), which is the assumed total area of seafloor disturbed over the next 10 years as a result of offshore export and inter-array cable emplacements for offshore wind facilities using the assumptions in Table A-4 in Appendix A. BOEM anticipates that there would likely be simultaneous cable-laying activities based on the estimated construction timeline. The impacts from a project that would overlap in cable-laying activities with a previously approved project would be assessed in additional project-specific NEPA analysis. While simultaneous cable-laying activities may disrupt fishing activities 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. BOEM does not anticipate differential impacts on fishery resources based on whether cable-laying activities occur sequentially or concurrently. However, both fishing and fishery resources may be differentially impacted based on the season in which the activities occur. Impacts on fisheries are discussed above, and impacts on fish and invertebrates are discussed in Section 3.3. Most construction activities would likely take place in the summer due to more favorable weather conditions. Thus, fisheries and fishery resources most active in the summer would likely be impacted more than those in the winter, including the longfin squid fishery.

Noise: Noise from construction, site assessment G&G survey activities, operations and maintenance, pile driving, trenching, and vessels could cause localized, temporary impacts on commercial fisheries and for-hire recreational fishing. The most impactful noise on commercial fisheries and for-hire recreational fishing is expected to result from pile driving. Section 3.3.1.1 discusses noise impacts on finfish, invertebrates, and EFH in further detail.

In the expanded planned action scenario, construction of 2,066 offshore foundations, including turbines and ESPs, would create noise and temporarily impact fish and invertebrates (Section 3.3.1.1 includes details on extent of impacts), and indirectly, temporarily impact commercial fisheries and for-hire recreational fishing. The greatest impact of noise is likely to be caused by pile driving. Noise from pile driving would occur during installation of foundations for offshore structures. This noise would be produced intermittently during construction of each project for approximately 2 to 3 hours per foundation or for 4 to 6 hours per day for the installation of two foundations per day. One or more projects may install more than one foundation per day, either sequentially or simultaneously over a 6- to 10-year construction period (Table A.7-4). Noise transmitted through water and/or through the seabed can cause injury and/or mortality to fish and invertebrates in a limited space around each pile, and can cause short-term stress and behavioral changes to individuals over a greater space. If the estimated risk of mortality for each of the 2,066 foundations in the expanded planned action scenario were summed, the risk of mortality is expected to occur over approximately 9,758 acres (39.5 km^2). The extent depends on pile size, hammer energy, and local acoustic conditions; based on estimates from the COP (Volume I, Section 4.2.3.4, Epsilon 2020a; Pyć et al. 2018), behavioral impacts would likely extend radially less than 5.7 miles (9.2 kilometers) around each pile. The radius for injury is estimated to extend up to 2,618 feet (798 meters), and the radius for potential mortality is estimated to extend 256 feet (78 meters) from each pile, given the proposed noise attenuation mitigation measures (Table 3.3-2). Therefore, the radius for potential injury or mortality would not overlap between any two foundations; the radius for behavioral effects could overlap among two or more foundations if multiple piles are driven simultaneously by one project or multiple projects. Finfish and invertebrate eggs, embryos, and larvae could also experience developmental abnormalities or mortality resulting from this noise, although thresholds of exposure have not been defined as they have been for adult finfish (Hawkins and Popper 2017; Weilgart 2018). In the area of behavioral effects, it is anticipated that some fishing activities may experience less catch due to movement of fish away from sound sources and/or reduced catch efficiency in hook and line fisheries (Skalski et al. 1992). These impacts on fish could affect fishing activities if vessels need to temporarily relocate to other fishing locations to continue to avoid or reduce impacts on revenue. This could lead to increased conflict in those locations, increased operating costs for vessels (e.g., additional fuel costs), and lower revenue (e.g., less productive area; less valuable species). Due to the relatively small footprint of injurious sound and the ability for most fish to swim away from noise sources, it is not anticipated that injurious sound would have stock-level impacts on commercial fish species. As noted above, the area of behavioral effects is much larger than injurious effects. If pile-driving noise were to negatively affect spawning behavior, then reduced reproductive success in one or more spawning seasons could result. This could potentially result in long-term effects on populations and harvest levels if one or more year classes suffer suppressed recruitment. However, the risk of reduced stock recruitment from pile-driving noise is considered low because the behavioral impacts on commercial fish species would only be present for the intermittent duration of the noise. After the cessation of pile-driving activity, fish behavior is expected to return to pre-construction levels (Jones et al. 2020; Shelledy et al. 2018).

Noise from G&G surveys of cable routes and other site characterization surveys for offshore wind facilities could also affect finfish and invertebrates, but is not anticipated to rise to fishery-level impacts since the noise would be very temporary in nature. G&G noise would occur intermittently over an assumed 2- to 10-year construction period. 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 more similar to common deep-water echosounders (Appendix A). Noise from G&G surveys, construction, trenching, vessel activity, and WTG operations and maintenance is expected to occur, but would have less of an impact on fish and invertebrates (Section 3.3.1.1 includes details on extent of impacts). This noise is expected to result in behavioral changes to commercial fish species that could impact the catch efficiency of some gear (hook and line); however, the noise from these sources is not anticipated to impact reproduction and recruitment of commercial fish stocks. Impacts on commercial fisheries and for-hire recreational fishing would be localized, temporary, and adverse.

BOEM anticipates that there would likely be simultaneous noise-producing activities from offshore wind projects based on the estimated construction timeline in Appendix A. While simultaneous pile driving and other noise-producing activities may disrupt fishing activities over a larger area than if activities occurred sequentially, the total time of disruption would be less than if each project were to conduct pile driving or other noise-producing activities sequentially. BOEM does not anticipate differential injurious levels of impact on fishery resources based on whether pile-driving activities occur sequentially or concurrently because the areas of injurious sounds would not overlap. The chance of exposure to behavioral levels of impact on fish populations is highly likely for concurrent projects in adjacent leases. Both fishing and fishery resources may be differentially impacted based on the season in which the activities occur. Most construction activities would likely take place in the summer due to more favorable weather conditions. Thus, fisheries and fishery resources most active in the summer would likely be impacted more than those that occur in the winter.

Port utilization: Ports are largely privately owned or managed businesses that are expected to compete against each other for offshore wind business. Major Northeast fishing ports are listed in Table 3.10-2. Of those major fishing ports, New Bedford, Hampton Roads, Atlantic City, Ocean City, and Montauk have been identified as possible ports to support offshore wind energy construction and/or operations. Of those ports, only New Bedford and Hampton Roads have been identified as possible construction staging area ports. Other ports, including Vineyard Haven, could be used for operations and maintenance. Other non-major fishing ports could also be used for operation and maintenance support. Port expansions would likely happen over the next 6 to 10 years, and the increase in port utilization would increase vessel traffic, peaking during construction activities, decreasing during operations, and increasing again during decommissioning. An increase in vessel traffic could result in delays or restrictions in access to ports for commercial and for-hire fishing vessels. As ports expand, maintenance dredging of shipping channels could increase (including increased frequency of dredging to maintain existing authorized depths and projects to increase channel depth, as described in Section 3.11) and may cause restrictions and delays for fishing vessels trying to access port facilities. The risk of restrictions and delays to access port facilities due to dredging would only increase when actual dredging activities occur, which would be infrequent. Port expansion and modification could have local, temporary impacts on commercial and for-hire fishing vessels in ports used for both fishing and offshore wind and other projects.

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, habitat conversion, navigation hazards (including transmission cable infrastructure), and space use conflicts. These impacts may arise from buoys, met towers, foundations, scour/cable protection, and transmission cable infrastructure. Using the assumptions in Table A-4 in Appendix A, the expanded planned action scenario would include up to 2,066 foundations, 1,723 acres (7.0 km^2) of foundation scour protection, and 1,221 acres (4.9 km^2) of new hard protection atop cables. Projects may also install more buoys and met towers. BOEM anticipates that structures would be added intermittently over an assumed 6- to 10-year period and that they would remain until decommissioning of each facility is complete.

Structures may alter the availability of targeted fish species in the immediate vicinity of the structures. For example, structure-oriented fish such as black sea bass, striped bass, lobster, and cod may increase in areas where there was no structure (natural or artificial) previously. HMS species may also be attracted to the wind turbine foundations. Flatfish, clams, and squid species are likely to remain in open soft-bottom sandy areas. Furthermore, altered community composition could change natural mortality of certain species due to predation (decrease) or refuge (increase), and increase competition between species, which could have beneficial and adverse effects, depending on the species. These effects are not anticipated to result in stock-level impacts that would in-turn impact fisheries. Various attempts to measure the linear extent of the reef effect have reported distances from 52.5 feet (16 meters) (Stanley 1994) to 1,968.5 feet (600 meters) (Kang et al. 2011) from a structure, and Rosemond et al. (2018) have suggested assuming a distance of 98 to 197 feet (30 to 60 meters) as a first approximation. There would be no effect in areas that already contain natural or artificial structures. These impacts could lead to increased opportunities for for-hire recreational fisheries and private recreational anglers targeting structure-oriented species, which could lead in-turn to space conflicts with commercial fisheries. Section 3.3.1.1 includes a more detailed discussion on fish aggregation and habitat alteration.

Future offshore wind structures are anticipated to provide forage and refuge for some migratory species, including finfish and invertebrates (e.g., summer flounder, monkfish, black sea bass, and lobster). While these behavioral effects may impact individual fish, they are not anticipated to result in broad changes in migration patterns that would in turn impact fisheries. Other physical oceanographic conditions such as temperature and salinity are a bigger driver of seasonal migration (Fabrizio et al. 2014; Moser and Shepherd 2009; Secor et al. 2018). Therefore, fishery-level impacts are not anticipated. Section 3.3.1.1 includes more details on the impacts of the presence of structures on finfish.

The presence of structures (including transmission cable infrastructure) would have long-term impacts on commercial fisheries and for-hire fishing by increasing the risk of allisions, entanglement or gear loss/damage, and navigational hazards. The presence of WTGs could also lead to long-term changes to fishing vessel transit routes during operations, which could affect travel time and trip costs. With respect to risk of fishing gear snares and maneuverability restrictions (including risk of allisions) within WDAs, fishermen have expressed specific concerns about fishing vessels operating trawl gear that may not be able to safely deploy gear and operate in a WDA 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-nautical-mile 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 state that their operations require a minimum distance of 2 nautical miles between WTGs, in alignment with the bottom contours, for safe operations (Wallace 2019). Due to the mobile gear being actively pulled by a vessel over the seafloor, the chance of snagging mobile gear on Project infrastructure is much greater than if—in the case of fixed gear—the gear were 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 impact mobile and fixed-gear commercial fisheries and for-hire recreational fishing. Inter-array and export cables would be buried below the seabed approximately 5 to 8 feet (1.5 to 2.5 meters); however, BOEM assumes that no more than 10 percent of the cables may not achieve the proper burial depth and would require cable protection in the form of rock placement, concrete mattresses, and/or half-shell. Mobile bottom-tending gear (trawl and dredge gear) could get hung up on these cable protection measures, and the cost of these impacts would vary depending on the extent of damage to the fishing gear. Lastly, comments from the fishing industry have included concerns that fishing vessel insurance companies may increase premiums or not cover claims for incidents within a wind energy facility if incidents/claims were to increase as a result of facility construction. At this time it is not possible to assess the potential number of insurance claims or future decisions by private insurance companies that could result in increased premiums or loss of coverage.

Maneuverability within WDAs would vary depending on many factors, including vessel size, fishing gear or method used, and weather conditions. Navigating through the WDAs 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 (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 pose additional navigational and maneuverability challenges around WTGs. The orientation of vessels transiting and fishing within the southern New England lease areas varies by activity, fishery, and area. Figures 3.10-12 through 3.10-18 show the directionality of VMS-enabled fishing vessels. This analysis uses the information conveyed in each individual position report (ping), which includes all fishing vessels, parsed into two speed categories representing transiting (speeds greater than or equal to 5 knots) and fishing activity (speeds less than 5 knots). The histograms on Figures 3.10-12 through 3.10-18 were chosen because they show how the orientation of vessels varies by activity, fishery, and area, and how this can be used to support different alternatives (discussed in Sections 3.10.4 and 3.10.6). The polar histograms are generated from all position reports broadcast within a certain area (the combined RI and MA Lease Areas including the WDA), and represent most fishing and transit activity for fisheries with VMS requirements. Each bar includes every ping reporting a course within a 5-degree compass window (e.g., 180 to 185 degrees are represented by one bar). The longer bars represent a greater number of position reports (pings) showing fishing vessels moving in a certain direction within the southern New England lease areas or the WDA. Overall, the plots show variability among activity type, fishery, and between a single project (i.e., WDA) versus the planned action scenario across the southern New England leases (RI and MA Lease Areas).

Figures 3.10-12 and 3.10-13 show the directionality of fishing vessels across the combined RI and MA Lease Areas. Figure 3.10-12 shows a majority of the 466 unique fishing vessels moving in a direction 10 to 15 degrees off due east-west throughout the southern New England lease areas. This direction is generally consistent with the former Loran lines. Figure 3.10-13 shows a majority of the 668 unique vessels transiting in a northwest-southeast direction through the southern New England lease areas. Figure 3.10-14 shows that the volume of actively transiting position reports created within the WDA greatly exceeds the volume of actively fishing position reports, showing a stronger northwest-southeast direction signal. The figures demonstrate a predominantly northwest-southeast transit pattern and slightly northeast-southwest fishing pattern in most of the southern New England lease areas, with a more prominent northwest-southeast and southeast-northwest transit and fishing pattern in the vicinity of the WDA (Figures 3.10-14 and 3.10-15).

Some of the figures show variability among fishery type. Figure 3.10-16 shows a majority of the 418 unique vessels in the sea scallop fishery transiting in a northwest-southeast direction through the southern New England lease areas. Figure 3.10-17 shows a majority of the 92 unique vessels in the squid, mackerel, and butterfish fishery fishing in a near east-west direction throughout the southern New England lease areas. Figure 3.10-18 shows a majority of the 24 unique vessels in the surfclam and ocean quahog fishery transiting in a northeast-southwest direction through the southern New England leas areas.

VMS is a good data source for understanding the spatial distribution of fishing vessels in the Northeast region. In 2018, 912 VMS-enabled vessels were operating in the Northeast across all fisheries. These 912 vessels represented a substantial portion (71 to 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 HMS and 10 percent of lobster/Jonah crab landings (NMFS, Pers. Comm., March 3, 2020). Of these vessels, approximately 67 percent fished or transited all reasonably foreseeable project areas, and 40 percent (366 vessels) fished or transited in the WDA in 2018 (NMFS, Pers. Comm., March 4, 2019).

As described in Chapter 2, the USCG's recently completed MARIPARS evaluated the need for establishing vessel routing measures. The final study, published on May 14, 2020, recommended all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would pass a WTG on either side every 1 nautical mile when traveling north-south or east-west, and every 0.6 to 0.8 nautical mile when traveling northwest-southeast or northeast-southwest (USCG 2020a). The final MARIPARS did not recommend implementation of a wider transit lane.

Overall, future offshore wind projects would have long-term, adverse impacts on commercial and for-hire fisheries due to the reduced area available for fishing and the navigation hazards to fishing vessels, especially larger commercial fishing vessels. Project proponents, as in the case of Vineyard Wind, may mitigate the economic losses of commercial and for-hire fisheries resulting from these impacts.

Installation of offshore cables for each offshore wind energy facility would require temporary re-routing of all vessels away from areas of active construction, including commercial and for-hire recreational fishing vessels. During operations, periodic cable maintenance and repair could have similar impacts, although these activities would be less frequent and extensive than installation.

The location of proposed offshore wind energy structures could affect the accessibility and/or availability of fish for commercial and for-hire fisheries. Potential displacement of fishing vessels and increased competition on fishing grounds could have long-term adverse impacts on commercial fisheries and for-hire recreational fishing. As mentioned above, in 2017 there were 4,300 federally permitted vessels operating in the Northeast across all fisheries (NOAA 2019d). The expanded planned action scenario would impact all fisheries and all gear types. Bottom tending mobile gear is more likely to be displaced than fixed gear. The future offshore wind projects would be more likely to displace larger fishing vessels with small mesh bottom-trawl gear and mid-water trawl gear, compared to smaller fishing vessels with similar gear types that may be easier to maneuver.

Space use conflicts could cause a temporary or permanent reduction in fishing activities and fishing revenue, as some displaced fishing vessels may not opt to, or may not be able to, fish in alternative fishing grounds. There could be increased gear conflicts as commercial fisheries and for-hire recreational fishing compete for space between turbines, especially if there is an increase in recreational fishing for structure-affiliated species attracted to the foundations (e.g., black sea bass). Commercial fishing vessels have well-established and mutually recognized traditional fishing locations or may be restricted on where they can fish due to fishery regulations. The relocation of fishing activity outside WDAs could increase conflict among commercial fishing interests as other areas are encroached. The competition is expected to be higher for less mobile species such as lobster, crab, surfclam/ocean quahog, and sea scallop.

One way to understand the level of commercial fishing activity that could be impacted is by looking at revenue exposure. Revenue exposure quantifies the dockside value of fish reported as being caught in individual wind lease areas. It is a starting point to understanding potential economic impact of future offshore wind project development if a harvester opts to no longer fish in the area and cannot recapture that income in a different location. Revenue exposure measures should not be interpreted as a measure of economic impact or loss. Actual economic impact would depend upon many factors—foremost, the potential for continued fishing to occur within the footprint of the wind lease area, as well as the availability of target species within the project areas. Economic impacts also depend on a vessel's ability to adapt by changing where it fishes. For example, if alternative fishing grounds are available nearby, or if alternative fishing methods are implemented, the economic impact would be lower. Thus, when aggregating across all fisheries (mobile and fixed gear) and all years, the revenue exposure estimate is a very conservative estimate of actual impacts.

Projected revenue exposure measures are based on the entire area or footprint of a given lease area and the year that future projects are assumed to be constructed (Table A-6 in Appendix A). Using the assumed construction schedule, Table 3.10-11 shows the projected average annual percentage of total Northeast fishery revenue exposed, by fishery management plan for 2020 through 2030. BOEM calculated future revenue exposure based on the annual average value of landings from 2007 to 2018 within the future wind energy facility footprints, as a percentage of the average total coast-wide value of landings. This analysis assumed that revenue exposure started in Year 1 of construction of each proposed or potential future wind energy project shown in the assumptions in Table A-6 in Appendix A, and continued through 2030 when the last project in the analysis is anticipated to be constructed. Actual impacts would extend throughout the entire operation of the facilities. Table 3.10-12 shows the percent of port revenue coming from all project areas included in the expanded planned action scenario for average landings between 2013 and 2018. The four landing port groups with the highest average annual revenue from all lease areas are New Bedford, Massachusetts; Point Judith, Rhode Island; Atlantic City, New Jersey; and Cape May, New Jersey. The highest revenue by dollar and percent exposure is Point Judith, Rhode Island. This is driven primarily by squid landings from leased areas offshore Massachusetts and Rhode Island. Atlantic City's exposure is driven primarily by surfclam landings in leased areas offshore New Jersey. However, smaller ports like Little Compton, Rhode Island, show a high dependency but relatively small average annual landings. Dependency would vary over time, by port, by fishery, and/or by vessel.

The results in Table 3.10-11 show increased revenue exposure as more offshore wind energy facilities are developed, although the overall cumulative percentage of revenue exposure remains relatively small for the majority of fisheries. A majority of the fisheries would have less than 2 percent of total revenue exposed by future offshore wind development. Some fisheries that have a high percentage of revenue exposure, such as skate (7.08 percent), have a relatively low average annual dollar exposure ($582,748), while other fisheries like sea scallop have a relatively low percent exposure (0.77 percent), but high average annual dollar value (greater than $3 million). The fishery with the largest combined percent exposure and dollar value is the Atlantic surfclam and ocean quahog fishery, which has high surfclam landings in lease areas offshore New Jersey and ocean quahog landings south of Cox Ledge. This analysis includes the WDA and all lease areas within the expanded planned action analysis. While all federally managed fisheries are required to submit a VTR, some fisheries like American lobster and Jonah crab do not have that requirement unless they are also landing a federally managed species. Thus, lobster and Jonah crab landings are captured in the "None–Unmanaged" row. According to NMFS, VTRs capture between 31 percent

(Connecticut) and 100 percent (Virginia and Maryland) of lobster landings between 2014 and 2019. Massachusetts and Rhode Island averaged 60 and 70 percent, respectively, over the same period. Similarly, VTR-required vessels landed between 18 and 100 percent of Jonah crabs in New England and the Mid-Atlantic (Benjamin Galuardi, Pers. Comm., 2020). If some of these wind energy facilities were not built, the exposed average annual revenue percentages in Table 3.10-11 would overestimate actual revenue exposure over time.

Increased vessel traffic: Increased vessel traffic associated with future offshore wind development could increase congestion, delays at ports, and the risk for collisions with fishing vessels. As stated in Section 3.11, future offshore wind projects would result in a small incremental increase in vessel traffic, with a peak during surveys and construction over a 6- to 10-year period, particularly when future offshore wind project construction activities overlap (Table A-6 in Appendix A). The presence of construction vessels could restrict harvesting activities in WDAs and along cable routes during installation and maintenance activities.

Climate change: Climate change is affecting commercial fisheries and for-hire recreational fishing. The primary driver of change associated with climate change is an increase in sea surface and bottom temperature. Warming of ocean waters has been shown to impact fish distribution in the Northeast United States by several species shifting the center of biomass either northward or to deeper waters. These have changed, and will continue to change, the distribution of commercial fishing effort, impacting commercial and recreational fishermen and coastal communities (Hare et al. 2016; Rogers et al. 2019). Additional impacts on commercial fisheries and for-hire recreational fishing can result from climate change events such as increased storm magnitude or frequency and shoreline changes. Implementation of offshore wind projects would likely result in a net decrease in GHGs as fossil fuel-type facilities reduce operations as a result of increased energy generation from offshore wind projects. This reduction in GHG emissions would offset any small increase in GHG emissions from offshore wind projects. Overall, an offshore wind project alone would likely not influence climate change enough to modify its impacts on commercial fisheries and for-hire recreational fishing. Assessing climate change impacts on the marine ecosystem is a challenge in conducting environmental assessments as the future end-state of the ecosystem, and animal's abilities to adapt, are not completely known. Renewable energy, including offshore wind, should reduce some of these impacts over time. See Section A.8.1 in Appendix A for details on the expected contribution of offshore wind activities to climate change.

Regulated fishing effort: Regulated fishing effort refers to fishery management measures necessary to maintain maximum sustainable yield under the Magnuson–Stevens Fishery Conservation and Management Act. This includes quota and effort allocation management measures. Offshore wind development could influence regulated fishing effort through two primary pathways, by changing fishing behavior to such an extent that overall harvest levels are not as predicted, and by impacting fisheries scientific surveys on which management measures are based. If scientific survey methodologies are not adapted to sample within wind energy facilities, then there could be increased uncertainty in scientific survey results, which would increase uncertainty in stock assessments and quota setting processes. Future spatial management measures may change in response to changes in fishing behavior due to the presence of structures. Impacts on management processes would in turn have short-term or long-term impacts on commercial and for-hire recreational fisheries operations. Section 3.12 discusses expanded planned action impacts on scientific surveys.

3.10.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, commercial fisheries and for-hire recreational fishing would continue to follow current regional trends and respond to current and future environmental and societal activities.

While the proposed Project would not be built as proposed under the No Action Alternative, BOEM expects ongoing activities and future non-offshore wind activities to have continuing temporary to permanent adverse impacts on commercial fisheries and for-hire recreational fishing, primarily through new cable emplacement, G&G survey noise, pile-driving noise, port expansion, presence of structures, vessel traffic, ongoing climate change and regulated fishing effort. The extent of impacts on commercial fisheries and for-hire recreational fishing would vary by fishery due to different target species, gear type, and location of activity. BOEM anticipates that the impacts of planned actions, especially regulated fishing effort, vessel traffic, and climate change, would be **moderate** to **major**. In addition to ongoing activities, reasonably foreseeable activities other than offshore wind may also contribute to impacts on commercial fisheries and for-hire fishing. Reasonably foreseeable activities other than offshore include increasing vessel traffic, new submarine cables and pipelines, marine surveys, marine minerals extraction, and port expansion activities (Table 3.10-1). BOEM anticipates that the impacts of planned actions other than offshore wind would be **moderate to major**. BOEM expects the combination of ongoing activities and reasonably foreseeable activities other than offshore wind to result in **moderate** to **major** impacts on commercial fisheries and for-hire fishing, primarily driven by the ongoing factors of regulated fishing effort and climate change.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with planned actions in the geographic analysis area combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in **major** impacts on commercial fisheries and **moderate** impacts on for-hire recreational fishing due to the presence of structures (gear loss, navigational hazard, and space use conflicts). The majority of offshore structures in the geographic analysis area for commercial fisheries and for-hire recreational fishing would be attributable to the offshore wind industry. The future offshore wind industry would also be responsible for the majority of impacts related to new cable emplacement and to pile-driving noise. However, BOEM expects that ongoing impacts resulting from regulated fishing effort, including changes to stock levels due to ongoing fishing mortality, climate change, and other factors, would continue to be one of the most impactful IPFs controlling the sustainability of commercial and for-hire fisheries in the geographic analysis area.

The No Action Alternative would forgo the fisheries monitoring that Vineyard Wind has committed to voluntarily perform, the results of which could provide an understanding of the effects of offshore wind development, benefit future management of commercial and for-hire fisheries, and inform planning of other offshore developments. However, other ongoing and future surveys could still provide similar data to support similar goals.

3.10.2. Consequences of Alternative A

The maximum-case scenario for commercial and recreational fisheries is for an approximately 800 MW wind energy facility with 100 turbine locations laid out in a grid-like pattern with spacing of 0.75 to 1 nautical mile. The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on commercial fishing:

- Number and type/size of foundation used for the WTGs and ESPs (90 34-foot [10.3-meter] monopiles and 10 jacket foundations have the greatest footprint).
- The export cable landfall has the potential to interfere with nearshore fishing grounds during construction.
- The route of the inter-array cables and the offshore export cable, including the ability to reach target burial depth or use cable protection measures when burial is insufficient. Vineyard Wind would bury the inter-array cables (connecting the WTGs and the ESPs within the WDA) and export cable to a target burial depth of 5 to 8 feet (1.5 to 2.5 meters). Vineyard Wind anticipates no more than 10 percent of the cables may not achieve the proper burial depth and would require cable protection in the form of rock placement, concrete mattresses, and/or half-shells. Such covers can change the fish habitat (soft-bottom habitat to hard-bottom habitat) and can also damage fishing gear and equipment, which in turn could cause a potential safety hazard should gear snag or hook on seabed structures.
- The time of the year during which construction occurs. 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, certain fisheries have peak times. Construction activities can affect access to fishing areas and availability of fish in the area, thereby reducing catch and fishing revenue.

Impacts from Alternative A alone would include the temporary or permanent reduction in catch or loss of access to fishing areas due to the presence of construction activities or changes in fish and shellfish populations that are the basis of fishing activities. Other impacts also include a temporary or permanent reduction in fishing activities and fishing revenue due to characteristics of the Proposed Action. This could include abandonment of fishing locations due to difficulty in maneuvering fishing vessels, fear of allisions with Proposed Action components (e.g., WTGs), increased risk of collisions with construction or lay vessels, and/or fear of damage or loss of deployed gear. Other impacts associated with Alternative A include implications in the management of fisheries resources due to changes in fishing effort (duration, location, methodology). For example, some New England fisheries are managed by an allocation of Days at Sea. If the duration of fishing trips changes as a result of the Proposed Action, the Days at Sea allocations may need to be revisited. Furthermore, fisheries research vessels may be unable to access an area due to operational safety concerns, and NMFS survey methodology would need to change to account for the inability to sample certain areas with the NMFS survey vessel. This restricted access would increase uncertainty in the existing management process used to set commercial and recreational fishery quotas. BOEM acknowledges that NOAA's Office of Marine and Aviation Operations endorses the restriction of large vessel operations to greater than 1 nautical mile from wind installations due to safety and operational challenges. NOAA evaluated the effects of the Vineyard Wind lease area on these survey operations and these effects are discussed in Section 3.12.

Alternative A alone would likely result in impacts (displacement, disruption, navigational hazards, entanglement and gear loss/damage, space use, and gear conflicts) that are expected to be local and short-term or long-term. This analysis assumes the maximum-case scenario. The Proposed Action includes the voluntary measures Vineyard Wind has committed to implement, which establish financial compensation agreements for Massachusetts and Rhode Island-based fisheries groups and are outlined in Table 3.10-13 and in the May 2019 COP (COP Addendum; Epsilon 2019a). With mitigation, BOEM expects the impacts of Alternative A alone would have a **moderate** impact on commercial fisheries and for-hire recreational fishing. If BOEM selected a less impactful alternative and included additional mitigation measures, then impacts would be further reduced depending on the level and efficacy of the mitigation provided.

The most impactful IPF caused by the Proposed Action would likely be the presence of structures, which would lead to permanent impacts, including space use conflicts, effort displacement, navigational hazards, entanglement, and gear loss/damage, as well as fishery changes due to habitat conversion. These impacts are anticipated to vary based on how individual operations are affected, with impacts likely to be adverse in the near-term, but may reduce over time to some entities if fishing practices adapt to the presence of structures. Other IPFs would likely contribute impacts of lesser intensity and extent, and would occur primarily during construction, but also during operations and decommissioning. For details, see Table 3.10-1.

In context of reasonably foreseeable environmental trends, the combined impacts of ongoing and planned actions, including Alternative A, would be of similar types to those described in Section 3.10.1.1, but may differ in intensity and extent.

Anchoring: Vessel anchoring would cause temporary impacts on fishing vessels and fishing activities. Anchoring vessels used in the course of Alternative A would pose a navigational hazard to fishing vessels and disturb approximately up to 4.4 acres (0.02 km^2). All impacts would be localized and potential navigation hazards would be temporary (hours to days). The anticipated impacts on commercial fisheries and for-hire recreational fishing of anchoring under Alternative A alone would be **minor**. Anchoring impacts on finfish, invertebrates, and EFH are discussed in Section 3.3.2.

In context of reasonably foreseeable environmental trends and planned actions, there would be increased vessel anchoring during survey activities and during the construction, installation, maintenance, and decommissioning of offshore components. In addition, there could be increased anchoring/mooring of met/ocean buoys. In context of reasonably foreseeable environmental trends and planned actions, anchoring could affect up to approximately 276 acres (1.1 km^2). Of this area, approximately 4.4 acres (0.02 km^2) would result from Alternative A, likely leading to **minor** impacts, and the remainder is the estimated result of other offshore wind projects in the geographic analysis area. All impacts would be localized and temporary (hours to days). In context of reasonably foreseeable environmental trends, combined anchoring impacts on commercial fisheries and for-hire recreational fishing from ongoing and planned actions, including Alternative A, would likely be **minor**.

New cable emplacement and maintenance activities: Alternative A would result in up to 321 acres (1.3 km^2) of seafloor disturbance by cable installation and up to 69 acres (0.3 km^2) from dredging, if used, prior to cable installation. Construction and installation of Alternative A could prevent deployment of fixed and mobile fishing gear in limited parts of the WDA from 1 day up to several months (if simultaneous lay and burial techniques are not used), which may result in the loss of revenue if alternative fishing locations are not available. Alternative A would result in localized, temporary, and **minor** impacts.

For export cable installation, Vineyard Wind would use a cable-laying vessel or barge to transport and install the export cable. Vineyard Wind would use a pre-lay grapnel run to locate and clear obstructions prior to cable laying.

Vineyard Wind might also dredge to remove sand waves along the OECC. These activities would require communications with fixed-gear fisheries to ensure no gear is deployed in the installation path. As provided in Table 3.10-6a and Table 3.10-6b, bottom trawl fishery provides the highest revenue from the WDA, followed by fixed gear fisheries including gillnet and pot. Fishing revenue from gillnet and pots from the WDA is estimated at $643,239 for the period of 2008 to 2017 with 489,562 landed pounds from the area (an average of $64,000 and 49,000 pounds per year). During the construction and installation activities, it may not be possible to deploy fixed gear in parts of the WDA, which may result in the loss of revenue, if alternative fishing locations are not available. In addition, temporary limitations to fishing activities for all gear types could occur along the OECC while the site is being prepared and cables laid. Vineyard Wind would communicate where and when activities would occur in the OECC to avoid conflicts with fishing activities. Vineyard Wind considers cable burial a priority, and would use iterative analyses of survey data, advanced burial techniques, and micro-routing to maximize burial and minimize the need for cable protection (Epsilon 2018c). Section 2.1.1.1.2 includes additional information on the cable burial risk performed by Vineyard Wind. Vineyard Wind may also engage with the fishing industry to determine what form of cable armoring (rock placement, concrete mattresses, and/or halfshell) would be the least likely to create new hangs for mobile gear.

During the construction and installation phase, an average of four cable-laying, support, and crew vessels may be deployed along sections of the OECC (COP Volume III, Section 7.8.2.1.2; Epsilon 2020b).

In response to a request from the MA DMF, Vineyard Wind has agreed to avoid cable laying activities in the spring season (April through June) within Nantucket Sound waters, in light of high concentrations of fishing activities (squid, whelk, and flounder fisheries) and natural resource events (spawning and egg laying). Thus, Vineyard Wind would conduct cable laying of nearshore segments from early September to late October (from the landfall site to the northeast portion of Martha’s Vineyard) using simultaneous lay and bury.

Although cable routes and lengths for most other offshore wind projects are not known at this time, using the assumptions in Table A-4 in Appendix A, the total seafloor disturbance from new cable emplacement within the geographic analysis area is estimated to be 8,153 acres (33.0 km^2). Overall, cable-laying activities would not restrict large areas, and navigational impacts would be on the scale of hours. In context of reasonably foreseeable environmental trends, the combined impacts from new cable emplacement and maintenance activities on commercial fisheries and for-hire recreational fishing from ongoing and planned actions, including Alternative A, would likely be localized, temporary, and **minor**.

Noise: Noise from G&G surveys, construction, trenching, pile driving, operations, and maintenance may occur during Alternative A. Noise can temporarily disturb fish and invertebrates in the immediate vicinity of the source, causing a temporary behavior change, including leaving the area affected by the sound source and reducing foraging activity (biting hooks). Impacts on commercial fisheries and for-hire recreational fishing would depend on the duration of the noise-producing activity (i.e., up to 6 hours per day, intermittently, for up to 102 days between May and December) and corresponding impacts to fish species, coinciding with fishing, and are anticipated to be **negligible** to **minor** from Alternative A alone. Noise impacts on fish and invertebrates are discussed in Section 3.3.2.

To reduce noise impacts during construction, Vineyard Wind would use noise reduction technologies during all pile-driving activities to achieve a required minimum attenuation (reduction) of 6 dB re 1 μPa. Vineyard Wind would also use PAM to monitor and record marine mammal vocalizations and monitor Project noise including vessel noise, pile driving, and WTG operation (Appendix D provides additional details on acoustic abatement and monitoring requirements).

The **negligible** to **minor** impacts of noise under Alternative A alone would not considerably increase the impacts of noise beyond the impacts under the No Action Alternative. In context of reasonably foreseeable environmental trends, combined noise impacts from ongoing and planned actions, including Alternative A, would be highly similar to the impacts under the No Action Alternative, and would range from **negligible** to **moderate** based on the sub-IPFs identified in Table 3.10-1.

Port utilization: As discussed in Section 2.1.1.2, Vineyard Wind would use an existing marina facility at Vineyard Haven. The owner of this facility intends to upgrade the facility irrespective of Vineyard Wind’s presence

(COP Addendum, Section 1.4; Epsilon 2019a). While these improvements would temporarily impact vessel navigation in the marina, the Proposed Action would not generate those impacts. Therefore, no impacts of this IPF on commercial fisheries and for-hire recreational fishing can be attributed to Alternative A, although ongoing and future activities, including other offshore wind projects, are expected to cause some impacts. The impacts of increased vessel traffic are discussed under the vessel traffic IPF, and Section 3.11.2 includes a discussion on ports to be used for the Proposed Action.

Presence of structures: The various types of impacts on commercial fisheries and for-hire recreational fishing that could result from the presence of structures, such as entanglement and gear loss/damage, navigational hazard and risk of allisions, fish aggregation, habitat conversion, migration disturbances, effort displacement, and space use conflicts are described in detail in Section 3.10.1.1.

Alternative A could result in up to 102 foundations and 151 acres (0.6 km^2) of scour and cable protection. The impacts from the presence of structures associated with Alternative A alone on commercial fisheries and for-hire recreational fishing are anticipated to range from **negligible** to **moderate** based on the sub-IPFs identified in Table 3.10-1, and would not increase the impacts across entire fisheries beyond those of the No Action Alternative. However, the expanded planned action effect on individual fishing businesses/fisheries depends largely on where the fishery is prosecuted. For example, as described previously, the impact of Alternative A alone on the surfclam and ocean quahog fishery is small since most of that fishery activity is predominantly outside the WDA. Whereas the impact on the squid fishery is much larger since that fishery has more activity in the WDA.

The installation of components, as well as the presence of construction vessels, could restrict harvesting activities in the WDA and along the OECC. For safety, USCG may elect to establish a temporary safety zone around anchored Project construction vessels within 12 nautical miles of the coast (Section 3.11.2). This zone would extend approximately 0.3 mile (500 meters) from the work vessel, and would cover approximately 0.19 square mile (0.5 km^2) (Epsilon 2018d). Vineyard Wind expects that the majority of the WDA and OECC would remain open throughout construction activities (COP Volume III, Section 7.6.3; Epsilon 2020b). For fishing vessels operating within the WDA, the impacts would depend on what construction activity is occurring. BOEM anticipates the greatest impacts during the foundation and cable installation. Although large areas would not be restricted for long periods, temporary limitations to fishing activities could occur. Vineyard Wind would communicate in advance where and when construction activities are scheduled to take place, to allow fishing vessels to alter their plans if needed to avoid impacted areas.

The location of the proposed infrastructure within the WDA could impact transit corridors and access to preferred fishing locations. Depending on the width and location of transit corridors through, or routes around, the WDA, commercial and for-hire recreational fishing fleets may find it more challenging to safely transit to and from homeports as there may be less space for maneuverability and greater risk of allision or collision if there is a loss of steerage. Transiting through the WDA could also create challenges associated with using navigational radar when there are many radar targets that may obscure smaller vessels and where radar returns may be duplicated under certain meteorological conditions like heavy fog. Larger vessels may find it necessary to travel around the WDA to avoid maneuvering among the WTGs. This is especially true for fishing vessels homeported in New Bedford, with the WDA being directly southeast of the port and regularly traversed by the commercial fleet. According to comments from commercial fishermen, the distance between wind turbines can make navigation or access more challenging for large fishing vessels trying to deploy fishing gear if spacing between WTGs is less than 1 nautical mile. In addition, smaller vessels could drift into WTG or ESP structures during times where steerage is limited (BOEM 2018b). Fishing vessels not able to travel through the WDA or deploy fishing gear in the WDA would need to travel longer distances to get around the WDA or find alternative fishing locations. This can result in increased travel time and trip costs. Additionally, as commercial fishing vessels typically stay out at sea over multiple days, BOEM expects that vessels would be navigating at nighttime or during adverse weather conditions. BOEM expects navigation in the WDA to be difficult at night, or in challenging weather conditions such as fog. Overall, BOEM expects the Proposed Action to have **moderate** impacts on fishing vessel movements within and near the WDA. For more discussion on vessel movements and impact assessment for fishing vessel navigation, see Section 3.11.2.

Alternative A could result in increased risk of allisions with infrastructure such as WTGs and ESPs (Section 2.3 and 3.11.2). As specified in the COP, the proponent would establish marine coordination to control vessel movements throughout the WDA and the OECC (COP Volume I, Section 4.2.2; Epsilon 2020a). In addition, USCG approval would be required for the WTGs and ESPs to be designated as PATONs, and WTGs and ESPs would be equipped with a number of navigational aids (e.g., marking, lighting, and AIS). In summary, BOEM expects that a risk of allision between Proposed Action infrastructure with fishing vessels would have a **moderate** effect on commercial fisheries and for-hire recreational fishing. However, this impact with mitigation measures identified in Appendix D could be mitigated through the revenue and gear compensation funds potentially decreasing the impacts to between **minor** and **moderate**.

The accessibility and availability of fish within the WDA/OECC may be affected by the location of the proposed infrastructure in some locations along the OECC and within the WDA. Vineyard Wind would bury the inter-array and export cables approximately 5 to 8 feet (1.5 to 2.5 meters) below the seabed. However, Vineyard Wind estimates that no more than 10 percent of the inter-array and export cables may not achieve the proper burial depth and would require cable protection in the form of rock placement, concrete mattresses, and/or half-shell, which, once in place, could interfere with fishing gear, damage equipment, and pose a safety hazard for vessels using mobile gear. Concrete covers may not stay in place if caught on towed mobile gear, which would leave the cable exposed. There are unconfirmed reports of a concrete mattress being dragged by a purse seine in Rhode Island waters. Vineyard Wind would schedule remote surveys of cable placement during Years 1, 2, 3, 6, 9, 12, 15, and 20 to confirm that cables remain buried and secure. In addition, the export cable would be monitored continuously with the as-built Distributed Temperature Sensing (DTS) System. This system would monitor if burial conditions have deteriorated or changed significantly and remedial actions are warranted.

Fishing activities within the WDA might be impacted to the extent that access to the WDA is restricted, fishing gear is entangled in protections placed over cables or around foundations of WTGs or ESPs, and/or restrictions on maneuverability due to the presence of infrastructure within the WDA result in the displacement of fishing vessels. The USCG's authority to establish safety zones only extends to the boundary of the territorial waters of the United States, which is 12 nautical miles from shore. Because the WDA is beyond this distance, neither USCG nor BOEM have the authority to restrict access to the WDA during construction or operations. In addition, the USCG has stated that they do not intend to restrict access to the WDA during operations.

With respect to risk of fishing gear snares and maneuverability restrictions within the WDA, fishermen have expressed specific concerns about fishing vessels operating trawl gear that they may not be able to safely deploy gear and operate in the WDA 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. Trawl and dredge vessel operators have commented that less than 1-nautical-mile 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. Fishing industry representatives state that their operations require a minimum distance greater than 1 nautical mile between WTGs, in alignment with the prevailing tidal currents for safe operations (Azavea 2020). Because a vessel actively pulls mobile gear over the seafloor, the chance of snagging the mobile gear on Project infrastructure is much greater than if—in the case of fixed gear—the gear were set on the infrastructure, or waves or currents pushed the gear into the infrastructure.

Vineyard Wind's supplemental navigational risk assessment (COP, Volume III, Appendix III-I, Epsilon 2020b), which BOEM and USCG reviewed and found adequate for the purposes of this EIS, demonstrates that it is technically possible to fish and transit through the proposed Project. Based on AIS data, trawling vessels require 180-degree turning diameters between 0.16 nautical mile and 0.86 nautical mile in good weather and sea conditions (larger diameters would be required in poor weather and sea conditions). These diameters are possible within the Vineyard Wind turbine layout, where vessels could turn either within a row of WTGs or from one row to another (COP, Volume III, Appendix III-I, Epsilon 2020b).

In addition, a formula from offshore wind energy facility and maritime navigation guidance developed by the Permanent International Association of Navigation Congresses found that the minimum fishing vessel channel widths of 0.33 nautical mile and 0.32 nautical mile were calculated for transiting and trawling vessels, respectively (COP, Volume III, Appendix III-I, Epsilon 2020b). Vineyard Wind's supplemental navigational risk assessment (COP, Volume III, Appendix III-I, Epsilon 2020b) concluded that several mitigation measures would maintain navigational safety (e.g., sound signals and/or AIS transponders installed on WTGs and ESPs, and lighting and high-visibility paint per USCG PATON permit, marine coordination on duty for the life of the Project).

Therefore, while Vineyard Wind's supplemental navigational risk assessment shows that it is technically feasible to navigate and maneuver fishing vessels and mobile gear through the WDA, BOEM is cognizant that maneuverability within the WDA may vary depending on many factors including vessel size, fishing gear or method used, or by environmental conditions. In addition, BOEM is aware that even when feasible to fish within the WDA, some fishermen might still not consider it safe to do so. However, BOEM also expects that, with time, many fishermen would adapt to WTGs spacing and would be able to fish successfully in the WDA. In addition, through compensation agreements with Rhode Island and Massachusetts, Vineyard Wind is providing funds to address concerns raised about safety and effective fishing in and around the Vineyard Wind 1 Project area and wind energy facilities generally. Examples of how the funds may be used include, but are not limited to, improvements in fishing vessels and gear, supporting widespread deployment of navigational equipment, development of new gear types or fishing methods, financial support for individual fishermen, purchase of updated safety equipment (e.g., radar, global positioning system, survival suits, emergency position-indicating radio beacons, and life rafts), and payment of increased insurance costs related to fishing in or around wind energy facilities.

Important sources of fishing revenue in the WDA from 2008 to 2017 included squids ($751,728), hakes ($552,841), monkfish ($429,179), American lobster ($295,229), skate ($274,905), flounders ($230,212), scup ($203,103), Jonah crab ($135,448), and scallops ($124,834). The average annual revenue for the WDA is estimated at $337,171 (Table 3.10-5a, based on total revenue from 2008 to 2017); however, revenue as high as $685,036 was reported for the WDA in 2016. Construction and installation activities would temporarily reduce access to the WDA (sections at a time), which can decrease the fishing revenue for fishermen who heavily rely on the WDA, such as those homeported in Point Judith or New Bedford (Table 3.10-7a). Fishing vessels may also choose to avoid fishing in proximity to construction activities, regardless of safety restrictions. During this time, they may relocate to other fishing locations and continue to earn revenue. However, this could cause increased conflict in those locations, and vessels may incur increased operating costs (e.g., additional fuel to arrive at more distant locations) and lower revenue (e.g., less productive area; less valuable species).

VTR data indicates that from 2008 to 2017, bottom trawl fishing revenue was estimated at $1.9 million (an average of $215,428 per year), representing 57 percent of total revenue from the WDA (Table 3.10-6a). In addition, over 2 million pounds of landings (67 percent of total) were harvested from the WDA between 2008 and 2017 using bottom trawl (Table 3.10-6b). Due to challenges with deploying mobile fishing gear in the WDA and along the OECC, some loss of fishing revenue is expected. However, this loss is not quantifiable due to uncertainty regarding where displaced vessels would shift effort, as such decisions are based on individual choices and due to inter-annual environmental variability impacting where vessels may be located at exploitable levels. A survey conducted by the University of Rhode Island of the Block Island Wind Farm found that all interviewed fishermen, commercial and recreational, continued to regularly fish in the Block Island Wind Farm area (ecoRI News 2019). It was also assessed that recreational fishing increased in the vicinity of the wind turbines because the turbines served as artificial reefs that attracted a variety of fish and marine invertebrates. However, the increase in recreational fishing resulted in increased vessel traffic for commercial fishermen to contend. Commercial fishermen also remain concerned about damage to fishing gear and colliding with turbine structures. Fishing compensation funds have been established by Vineyard Wind to compensate fishermen for lost gear.

The for-hire recreational fishery has identified Gordon's Gully, in the southern part of the WDA, as an area that construction and installation activities may particularly impact. Trolling for highly migratory fish may involve many feet of lines and hooks behind the vessel and then, once they are hooked, following large pelagic fish. If the fishing is good in the area, then several vessels may be involved in the fishery. Given the navigational and maneuverability challenges under normal circumstances, it is expected that this type of fishing may be further constrained where it overlaps with construction and installation activities. For-hire fishing boats are typically smaller compared to commercial fishing boats, which improves their maneuverability; however, construction traffic and noise can cause fish to leave the area. Therefore, although it is expected that for-hire fishing would have more flexibility for use of the area during construction and installation, there is the potential for behavioral impact on target recreational species as described above (Michael Pierdinock, Pers. Comm., September 19, 2018; FAO 2018).

Hook and line anglers targeting large pelagics such as makos, threshers, and bluefin tuna need to safely navigate around the base of the WTGs to avoid damage to gear or entanglement (Michael Pierdinock, Pers. Comm., September 19, 2018). Recreational anglers harvesting tunas, sharks, and billfish also noted that spacing of the WTGs could impact maneuverability to fishing locations due to the large size, strength, and swimming speed of larger species that require significantly more space to fight on rod and reel compared to other species. Some commercial and for-hire recreational users recommend spacing of more than 3 nautical miles for WTGs. Concerns have been expressed by fishing fleets consisting of smaller boats and a single operator without a crew, such as those often homeported on Martha's Vineyard, and the ability for fishing to continue within the WDA during operation. Even if fishing within a wind energy facility is technically feasible, vessel operators may nonetheless perceive they are not able to safely fish there, resulting in *de facto* exclusion areas. Indeed, fishermen have voiced their reluctance to enter wind facilities, particularly during low-visibility weather events. Trolling, bait fishing, and shark fishing could be more challenging for for-hire recreational fishing as the fish could use foundations to break free. Some fishermen may also opt to stop fishing in the WDA entirely, as they may not be willing to incur the possible safety and financial risks associated with fishing in the WDA.

In addition to disrupting fish harvesting activities, the presence of the WTGs may affect fisheries research surveys. Large vessel survey operations, low-flying aerial surveys, or operations towing lengthy gear may determine that operating within offshore wind facilities is not within their safety limits. This could exclude the WDA from surveyed areas, and NOAA has determined that survey methodology will need to change due to restricted ability to access wind development locations to conduct long-standing survey operations. The effects of the Vineyard Wind lease area on these survey operations and potential mitigation are discussed in Section 3.12. Vineyard Wind would inform fishermen of areas where foundation or cable protection is used. Vineyard Wind would also communicate project construction activities and project schedule and work with the fishing industry to ensure that safe fishing can continue in the WDA. To the extent allowed by law, mitigation under consideration by BOEM includes Vineyard Wind's voluntary proposal to establish a financial compensation program for documented loss of income due to inability of fishing vessels to access previously fished locations within the WDA and temporary loss of use during cable maintenance. Compensation would be restricted to demonstrated loss of net revenue due to inability to access fishery resources within the WDA. This voluntary compensation would be directly negotiated between the claimant and the lessee, and could include direct payments to fishermen and/or funding of fishery-directed projects (e.g., research, infrastructure improvements, seafood promotion). Voluntary financial compensation would be also provided for damage to or loss of fishing gear due to collision with proposed Project infrastructure within the WDA and along the OECC. Financial compensation agreements are often developed to address gear loss, such as in the Gulf of Mexico, where there is a public gear loss compensation program (Fisheries Contingency Fund). There has been an average of 17 claims between 2007 and 2017 averaging $126,782 in awarded claims over this period (NMFS, Pers. Comm., September 14, 2018).

Vineyard Wind has expressed its commitment to work with the fishing industry so that both the Project and the fishing industry can grow together offshore Massachusetts (Table 3.10-13 and Appendix D). Vineyard Wind has voluntarily established gear loss and revenue compensation funds for fishing interests[30] based in Rhode Island and Massachusetts totaling approximately $25.4 million[31] over the 25-year operation term and 5-year decommissioning term of the Project. Vineyard Wind has expressed that funding for fishing interests from all other affected states would be added to either of these existing funds or grouped into a third fund. In the absence of a clear fund for fishing interests in other affected states, Vineyard Wind has developed a voluntary measure to set aside

[30] Fishing interests are broadly defined to include owners and operators of vessels, vessel crews, shoreside processors, vessel supplier and support services, and other entities that can demonstrate losses directly related to the Vineyard Wind 1 Project.

[31] The $25.4 million is calculated as follows: Rhode Island economic exposure was valued at $6,190,281 over 30 years using a 2.5 percent annual escalator to the initial 1-year exposure value. When the Rhode Island Fisheries Advisory Board asked to front-load the initial payment, the amount in nominal dollars was reduced to $4.2 million (but the value in real terms is still $6.1 million). For Massachusetts, the economic exposure plus upstream and downstream multipliers is $19,185,016. The Rhode Island $6,190,281 plus the Massachusetts $19,185,016 equals $25,375,297. The $25.4 million voluntary compensation funds are calculated from fishing VTRs, dealer reports, and vessel monitoring system data (for detailed methodology, see King [2019] and the Memorandum of Agreement between Vineyard Wind and the Massachusetts Executive Office of Energy and Environmental Affairs [Vineyard Wind 2020a]).

$3.3 million[32] and establish a fund for claims of direct compensation from other affected states. These compensation funds are based upon an analysis of the NMFS fisheries revenue exposure (Table 3.10-4a) conducted by Vineyard Wind with adjustments made for under-reported fisheries such as lobster and Jonah crab (COP Volume III, Appendix III-P, Epsilon 2020b). The Vineyard Wind analysis considered economic impacts from construction and operations within the WDA as well as impacts from cable laying, fishing congestion, and shore-side indirect and direct impacts. However, the report primarily found potential impacts from direct fisheries revenue from construction and operation of the wind facility. The Vineyard Wind analysis and compensation funds are generally consistent with the revenue exposure information provided in Table 3.10-4a, which shows an annual average revenue exposure of $478,824 over 12 years. When multiplied over 30 years (25-year operations term and 5-year decommissioning term), the sum is approximately $14 million. Based on these analyses, the compensation funds should be adequate to cover any gear and/or revenue losses over the life of the Project. Lost or damaged gear associated with fishing within the WDA would be compensated directly through a separate process and with funding aside from the Direct Compensation Fund, and would be paid on an as-needed basis (COP, Volume III, Appendix III-P; Epsilon 2020b). The funds would be structured similar to other voluntary compensatory mitigation funds, such as those established to compensate fishermen for losses associated with oil and gas exploration and development (e.g., NOAA's Fishermen's Contingency Fund, Deepwater Horizon Seafood Compensation Program, Louisiana Fishermen Gear Compensation Fund, as well as the gear loss fund established by Deepwater Wind (now owned by Orsted) for the Block Island Wind Farm). Fishermen, fishing companies, and companies that support fishing interests would be able to submit claims of direct impacts or losses during any phase of the Project (construction, operation, decommissioning) to the claims administrator. Direct impacts or losses for which claims may be filed include, but are not necessarily limited to, lost or damaged gear associated with fishing within the Project area and lost revenues related to the Project's interference with fishing activities (if any). It is not possible at this time to assess the likelihood or potential magnitude of gear damage or lost fishing time associated with bottom gear snags along the OECC after construction. However, it is reasonable to expect that it would be rare, occurring where bottom conditions prevent full burial of cables and require cable protection on the seafloor, and to expect that fishermen would be fully compensated for any related economic losses as part of a fishermen compensation program, such as the Direct Compensation Fund. It is also reasonable to expect that fishermen would be compensated for lost fishing income that could result from disruptions in the scheduling of OECC construction and/or shifts in the distribution or concentration of fish in the vicinity of the OECC that result in unexpected losses in fishing revenues (COP Volume III, Appendix III-P, Epsilon 2020b).

On February 21, 2019, Vineyard Wind and Rhode Island Coastal Resources Council signed an *Agreement Regarding the Establishment and Funding of the Rhode Island Fishermen's Future Viability* Trust (Table 3.10-13 and Appendix D). Under the agreement, the signing parties agreed to establish the Rhode Island Fishermen's Future Viability Trust to "advance the goals of the Ocean SAMP [Special Area Management Plan] and support and promote the compatibility of the offshore wind and commercial fishing interest within Rhode Island's GLD [Geographic Location Description]" and to provide a "fund to address concerns raised about safety and effective fishing in and around the Vineyard Wind project area and wind farms generally." See Appendix D for more information. Under the agreement, Vineyard Wind would make an annual payment to the Trust of $2.5 million every year for 5 years. Funds could be used, among other things, to improve fishing vessels and fishing gear, support deployment of navigational equipment, develop new gear types or fishing methods, provide financial support for individual fishermen, purchase updated safety equipment (radar, global positioning system, survival suits, emergency position-indicating radio beacons, life rafts), and pay increased insurance costs related to fishing in or around wind energy facilities.

As part of the NHPA Section 106 consultation process, Vineyard Wind has proposed not to use the three northernmost turbine locations as a mitigation measure to reduce visual impacts on the Nantucket NHL. BOEM could require this as a condition of COP approval. Moving WTGs away from the northern portion could improve access to the portion of the scallop fishery that has higher vessel density in that portion of the WDA. Further, the surfclam/ocean quahog fishery used to be quite important in the northernmost section of the WDA. However, areas

[32] The value is based on communication from Vineyard Wind (Geri Edens, Pers. Comm., October 11, 2020) and includes Connecticut, New Jersey, and New York. Payment structure and frequency obtainment would be similar to other established funds.

of scallop, surfclam/ocean quahog, and squid concentration vary substantially from year to year, meaning the benefits of this mitigation for commercial fisheries may vary over time.

There are also cultural and traditional values to fishermen from fishing that go beyond expected profit. Fishermen 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. There are, however, no specific mitigation measures for such impacts. See Section 3.7 for additional information regarding cultural and traditional values to fishermen.

Disruption of fishing in the WDA and along the OECC could also carry potential implications for seafood processors and distributors. If commercial fisheries experience decreased catch due to the inability to operate in the WDA or being unsuccessful in finding alternative fishing locations that provide comparable catch and fishing revenue, seafood processors and distributors could see lower volumes and/or value of product. This could also impact other businesses that supply the commercial fishing industry. However, it is highly unlikely that seafood processors would see a measurable loss of available product given that less than 2 percent of landings from any given fishery (average of 0.20 percent and high of 1.61 percent) are sourced from the WDA (Table 3.10-4b), that the product is available outside the WDA, and that there are no regulatory restrictions on accessing product in the WDA. Regional economic impacts are discussed in Section 3.6.2.

If operational impacts on access to fishery resources were unmitigated, the impacts would be **moderate** to **major**. However, implementation of mitigation measures identified in this section, Table 3.10-13, and in Appendix D could reduce impacts to **moderate** depending on the level and efficacy of the mitigation provided. The impacts on other fishing industry sectors, including seafood processors, distributors, and shoreside support services, are expected to be **minor** to **moderate**.

Permanent habitat alteration in the form of scour and cable protection would reduce the habitat for species such as winter flounder and displace species that prefer soft-bottom habitat (e.g., squid) from the area immediately surrounding the foundation footprint. The creation of hard-bottom habitat would, however, benefit structure-oriented and/or hard-bottom habitat species such as American lobster, striped bass, black sea bass, scup, and Atlantic cod—and potentially increase their habitat (Daigle 2011). For example, from the United Kingdom we have learned that lobsters do not abandon offshore wind facilities, nor are catch rates different at sites adjacent to a wind facility (Roach et al. 2018). Groundfish species can also experience changes in habitat due to changes to the ocean floor in the WDA. The base of WTGs also has the potential to serve as an artificial reef and attract forage fish, HMS, and game fish, potentially increasing the for-hire recreational fishing opportunities. Section 3.3 discusses the potential beneficial impact on fish populations due to the addition of hard bottom structures within the WDA.

With respect to gear type, hard cover could displace historic bottom trawl and gillnet fisheries by reducing fishable area, and by increasing recreational hook and line activity in the vicinity of turbines. The conversion of soft sediment habitat to hard bottom via protective cover could also negatively impact the bottom trawl industry by increasing the risk of net hangs and vessel instability, and generally decreasing trawlable habitat.

Additional mitigation measures to address accessibility to, and availability of, fishing resources include:

- Long-term monitoring of cable placements to confirm cables remain buried and that rock placement and concrete mattresses remain secured and undamaged; and
- Communicating with fishermen over the life of the Project to address changes in access to and availability of fish.

Vineyard Wind is developing a framework for pre- and post-construction fisheries monitoring to measure Project impacts on fisheries. Furthermore, benthic monitoring would include ten monitoring sites, two sites from the five different bottom habitat types present in the WDA and OECC, which would be sampled before and after construction for comparative analyses. Two sites of each habitat type would be chosen to ensure reliability in conclusions and increase statistical power of the data. Three control sites outside, but near, the Project area and with comparable physical and environmental characteristics would also be sampled to monitor natural environmental shifts that occur unrelated to the Project. The habitat monitoring sites and control sites would be monitored after construction during Years 1, 3, and 5, and would include the following methodologies:

- Benthic grab sampling and analysis
- Sediment profile imaging acquisition and processing
- High resolution multibeam depth sounding and video survey

Fisheries monitoring would also be conducted before, during, and after construction in the Project area and control areas to support a "beyond Before After Control Impact" analysis (i.e., sampling at multiple control sites at multiple periods before and after impact). Sampling would be conducted four times: pre-construction (to assess baseline conditions); during construction; and at two different intervals during operation (i.e., 1 year after construction and then post-construction). Each of these four assessment periods would capture all four seasons of the year. Fisheries survey methodologies include:

- Trawl survey for finfish and squid
- Ventless trap survey
- Plankton survey
- Optical survey (drop-camera) of benthic invertebrates and habitats

As proposed in Vineyard Wind's Fisheries Communication Plan and potentially enforced through COP conditions would be a daily two-way communication during construction that would include daily communication between fisheries and Vineyard Wind so that harvesters are aware of the day's activities and the developer is aware of where fishing is occurring. A time of year restriction for activities such as jet plowing or pile driving, however, would not result in benefits to squid eggs given that up to 80 squid vessels throughout the year (on average between 30 to 60) are bottom trawling on spawning squid and squid egg mops (based on the number of squid vessels in a given month from 2007 to 2017; NMFS, Pers. Comm., November 2, 2018).

To better understand how fishing trips may be impacted by longer trip durations due to altered or slowed routes, NMFS provides an estimation of trip costs for commercial fisheries (Table 3.10-10; Das 2013). The cost for commercial fishing vessels is typically divided into annual costs and trip costs, both of which affect net revenue. Annual costs include items such as permits, gear, and vessel maintenance. Trip costs are costs incurred during each fishing trip and include bait, fuel, loss or damage of gear, food, ice, oil, other supplies, and water. Trip costs typically increase with trip duration and the size of the vessel (Table 3.10-10). In the considered data set, 64 percent of all trips were single-day trips, and 69 percent of all trips used medium-sized vessels. The average trip (or operating) cost for a single-day trip in a medium-sized vessel was $358 (Das 2013). Multiday trips in medium-sized vessels had an average trip cost of $7,446 and $16,380 for large vessels (Table 3.10-10). Trip costs also vary by gear type, and vessels equipped with mid-water trawl, dredge, mid-water pair trawl, and other types of trawl typically have higher average trip cost (Das 2013). Overall, fishing costs have been estimated to be approximately 50 percent of landed value (COP Volume III, Section 7.6; Epsilon 2020b), although there can be considerable variability depending on vessel size, gear, target species, trip duration, and fishing success. With respect to the individual cost items that make up the variable trip cost, the average cost is highest for fuel (mean cost of $3,188, median cost of $301), food (especially for multiday trips, $258), the replacement of damaged equipment ($229) and ice ($207). In fact, Das (2013) found the cost of fuel accounted for about 78 percent of the total share of trip costs. The average cost for bait, water, supplies, and oil are typically less than $100, with the median value of bait often being $0, as many vessels do not use bait (Das 2013).

As expected, trip cost is highly positively correlated with fuel price and trip duration. The WDA is approximately 9.9 miles wide (16 kilometers) and 31 miles long (50 kilometers). Therefore, fishing vessels transiting through the middle of the WDA have only 9.9 miles (16 kilometers) to travel; however, vessels that may be required to avoid the WDA would need to travel around the WDA, both increasing the travel time and trip cost compared to a more direct route through the WDA. The estimated overall increase in annual transit costs for fishing vessels from all states (Massachusetts, Rhode Island, Connecticut, New York, and New Jersey) is $83,699 (COP Volume III, Appendix III-P, Epsilon 2020b). Fishing vessels traveling to more distant fishing locations would incur additional expenses if fishing within the WDA were no longer an option for those vessels due to safety concerns or difficulty deploying the gear (bottom trawl and dredge). Depending on fishing locations, the total trip time and catch revenue, the additional fuel costs associated with transit around the WDA could have a substantial impact on fisheries profits. It is also possible that some fishermen may reduce the number of trips or become inactive if they cannot cover their trip costs. Additional impacts of longer trips, also connected to the uncertainty of income due to the displacement of fishing locations, could result in cultural impacts on families (e.g., increased time away from home and family). Section 3.6 assesses the broader social impacts of changes on the commercial fishing industry. Additionally, if over time fishing in the WDA has a history of accidents and collisions, some insurance policies may decide to decline insurance for vessels operating in the WDA, increase the insurance cost, or make the WDA an insurance exclusion zone. In general, BOEM expects that potential changes to vessel transit routes and chosen fishing locations as a result of the Proposed Action would have a **moderate** effect on commercial fisheries and for-hire recreational fishing.

Commercial fishing vessels, although operating in a large licensed FMP area, have well established and mutually recognized traditional fishing locations; the relocation of fishing activity outside the WDA or OECC may increase conflict among fishermen as other areas are encroached. The competition is expected to be higher for less-mobile species such as lobster, crab, surfclam/ocean quahog, and scallop, and less so for finfish. For example, the Proposed Action is located in lobster Nearshore Management Area 2. In that area, permits are spatially constrained to remain in that area. As a result of displacement during construction, BOEM expects increased competition over available fishing grounds where species presence is more static and regulations constrain where fishermen can fish. As a result of regulatory constraints and/or fishing agreements, open/trawlable bottom, and other cost factors, some displaced fishing vessels may opt not to or may not be able to fish in alternative fishing grounds, and may thus exit the fishery. As a result of all of these factors, fishermen may not have the ability to adapt to changing conditions by going to their next best alternative location. Therefore, economic loss in one area cannot always be compensated by revenue gains in another area. For pelagic species like squid, if the center of the squid resource is located where construction activity is occurring then the resource may not be available during the time that the resource and construction activity overlap. Thus, construction and installation activities (anchoring, new cable emplacement/maintenance, noise, presence of structures, and vessel traffic) are expected to have a **minor** to **moderate** impact on commercial fisheries and for-hire recreational fishing.

As with construction and installation of Alternative A, some commercial and for-hire recreational fishing vessels that currently fish in the WDA or along the OECC may choose to fish in other locations during the operations and maintenance of Alternative A due to restrictions on maneuverability from the presence of structures. Choosing alternative locations with similar harvest potential and expenses could mitigate economic impacts from not fishing in the WDA; however, it could also potentially increase conflict over other fishing grounds. This displacement has the potential to impact the financial outcomes of fishing vessel owners. Vessels already fishing in the areas where displaced vessels would be forced to fish would also be impacted by the Project, as this would increase competition over existing fish stock. In addition, increased vessels fishing in the same locations may increase navigational hazards, and increase fishing pressure on other fish species in discrete areas. While Alternative A may affect all fisheries and all gear types, some gear types may be more adversely affected. Bottom tending mobile gear is more likely to be displaced than fixed gear. The fixed gear fisheries, including the lobster and gillnet fisheries, are less likely to be displaced from the WDA. However, some fixed gear methodologies, like the length of the pot trawl, may be modified to improve performance in a wind facility. Dredge gear fisheries, including the sea scallop fishery and surfclam/ocean quahog fishery, are not very active in the WDA and generally use shorter tows than trawl fisheries. The small mesh bottom fishery targeting whiting and squid are most likely to be impacted. Voluntary compensation by Vineyard Wind could reduce potential impacts on displaced fishermen from the WDA for potential decreases in revenue. BOEM expects operations and maintenance of Alternative A within the WDA/OECC would have **moderate** impacts on the commercial fisheries and **minor** to **moderate** impacts on the for-hire recreational fishing industry (Appendix D).

NOAA found that of the 218 pot and gillnet permits from Massachusetts (e.g., New Bedford, Westport, Fairhaven, Cape Cod, and other smaller ports), along with those from Rhode Island (e.g., Point Judith, Newport, Tiverton, Little Compton), approximately 25 permitted vessels would lose the majority of the revenue if not able to access traditional grounds within the RI and MA Lease Areas (Kirkpatrick et al. 2017). On average, a vessel would experience \$819 per trip loss (revenue net of variable costs), with a maximum annual loss of slightly over \$8,000 for one permitted vessel (from an analysis of eight wind lease areas). Certain vessels may be financially impacted if they historically fish within the WDA or OECC. Given that the footprint of the WDA is only a small fraction of the total RI and MA Lease Areas, it is expected that Alternative A would have **moderate** impacts on the commercial fishing sector as a whole, but **major** impacts on certain individual vessels that intensely use the Alternative A area.

Although BOEM may consider impacts to be **moderate** on average, it is important to consider that pelagic fishery resources are highly dynamic. In a given year, it is possible that the center of the resource's exploitable biomass would be found within the WDA during construction, installation, operations, and maintenance. If that were to occur, some fisheries—like the squid trawl fishery—may not be able to safely operate and harvest the resource in the WDA using status-quo fishing techniques. In this situation, a large portion of annual income for vessels may be inaccessible during construction or operations, resulting in **major** impacts on individual vessel owners for a given year that could have longer-term impacts due to low operating capital. However, when the center of exploitable biomass lies outside the WDA, impacts would be **moderate**.

Thus, even though the likelihood of the limited fishery resource availability and construction, and installation or operations and maintenance co-occurring in time and space is low, impacts on some commercial fisheries may be **moderate** to **major** and impacts on for-hire recreational fishing **minor** to **moderate**. With mitigation measures identified in Appendix D, BOEM anticipates that the use of compensation payments to affected commercial fishermen could reduce impacts to **moderate** and **minor** to **moderate** for for-hire recreational fishermen.

Impacts during decommissioning would be similar to the impacts during construction and installation. Temporary disruptions to commercial and for-hire recreational fishing activities would occur in the immediate vicinity of the WDA while Vineyard Wind disassembles WTGs and ESPs, removing them 15 feet (4.6 meters) below the mudline and shipping them to ports for disposal. Removal of scour protection around structures and the hard protection atop portions of cables would cause temporary impacts, but would alleviate the possibility of future hazards to fishing (e.g., gear damage). Removal of the OECC, if required, would also generate temporary disruptions. As with construction, decommissioning activities would have larger impacts if conducted during the peak fishing and spawning (e.g., squid) seasons.

Under Alternative A, the WTG layout is designed such that the foundations would be in a northwest/southeast alignment. As the VMS-based polar histograms show (Figure 3.10-12), this would primarily benefit transiting fishing vessels (primarily scallop) from New Bedford to fishing grounds on Georges Bank. However, this layout would not align with fishing patterns observed in adjacent project areas (Figure 3.10-13). If Alternative A facility design was responsive to fishing vessel activity patterns in just the WDA, the expanded planned action impact of different spacing and orientation would be greater than if Alternative A were to adopt a uniform layout consistent with adjacent project areas to facilitate both fishing and transiting. The combined impact of Alternative A with future offshore wind projects is greater to fishing activity and less impactful for transiting activity.

Figure 3.10-20 shows the relative intensity of reported commercial fishing ex-vessel revenues in the Northeast and Mid-Atlantic regions for commercial fisheries relative to the locations of lease areas for current and planned offshore wind energy facilities. In general, fisheries do not have high relative revenue intensity within the lease areas compared to nearby waters. Lease areas were chosen to reduce potential use conflicts between the wind energy industry and fishermen (BOEM 2014c).

Alternative A and other future offshore wind development would impact commercial fishing revenue. Section 3.10.1.1 includes further details. Table 3.10-11 shows the predicted average annual percentage of total Mid-Atlantic and New England fishery revenue exposed by fishery (as defined in the relevant fishery management plan) for 2020 through 2030. The WDA would only account for a small portion of the exposed revenue in the New England and Mid-Atlantic regions. The average annual percentage of total Mid-Atlantic and New England fishery revenue exposed by fishery within only the WDA (2022) would be less than 0.5 percent for all fisheries but would vary greatly between individual fisheries in certain years (Table 3.10-11). For example, the squid fishery may average around $195,000 from the WDA, but in 2016 it harvested close to $1 million (1.61 percent of total revenue) from the WDA (Table 3.10-4a and 3.10-4b). Overall, the average annual percentage of fishery revenue exposed throughout the construction timeline for all existing lease areas ranges from 0.13 percent ($2,262 revenue exposed for HMS) to 7.08 percent ($582,748 revenue exposed for Skate FMP). The total average annual fishery revenue exposed by fishery ranges from $2,262 (HMS) to $3.5 million (Scallop FMP). Section 3.10.1.1 and Table 3.10-11 provide a more detailed discussion of fishery revenue exposure.

In particular, similar projects in proximity or adjacent to the WDA may impact fishing revenue landed in local ports. If commercial fisheries experience decreased catch due to the inability to operate in the WDAs for the projects or being unsuccessful in finding alternative fishing locations that provide comparable catch and fishing revenue, seafood processors and distributors could see lower volumes and/or quality of product. This could also impact other businesses that supply the commercial fishing industry (see also Section 3.6). The published COP by Deepwater Wind South Fork LLC (Ch2m 2018) provides information regarding impacts on commercial and recreational fisheries in the RI and MA Lease Areas, South Fork Wind Farm, and South Fork Export Cable fisheries study corridor (the South Fork Wind Farm Project is located in the southern part of OCS-A0496; Figure 3.10-20). As indicated in the technical report, fishing vessels from Massachusetts, Rhode Island, Connecticut, and New York conduct fishing activities in the RI and MA Lease Areas, with some vessels also operating from New Jersey, Virginia, and North Carolina. The largest annual revenue (based on 2006 to 2015 data) was landed in New Bedford ($407,000), Point Judith ($391,100), and Newport and Little Compton ($188,000 each). Ports of Little Compton (8.5 percent), and Chilmark and Westport (5.4 and 5.1 percent, respectively) had the greatest percentage of revenue sourced from within the RI and MA Lease Areas. Fishing vessels in the RI and MA Lease Areas typically target monkfish, lobster, skates, sea scallops, and surfclam/ocean quahog, where by FMP, the largest annual revenue comes from monkfish ($247,300), sea scallop ($193,300) and surfclam/ocean quahog ($98,700). Together with other proposed projects, such as an offshore wind power project off Virginia Beach (to be located in OCS-A 0497), the South Fork Wind Farm impacts would overlap with potential impacts of Alternative A and other adjacent projects, potentially reducing fishing revenue for affected commercial fishery and for-hire recreational fishing (Section 3.10.1).

Block Island Wind, now in operation since December of 2016, predicted permanent loss of 0.35 acre (0.15 hectare) of potential mobile fishing ground and identified a potential obstacle to traditional navigation routes (TetraTech 2012). However, as the environmental report concluded, significant adverse effects of the project on existing commercial fisheries in the Block Island Wind area were not predicted; such potential effects were avoided and mitigated because the project spaced turbines to allow access through and around the WTG array, included a wide transit corridor, provided sufficient cable burial depth, and did not propose any vessel exclusions within the project area.

Using the assumptions in Appendix A, there could be up to approximately 2,066 foundations, 1,723 acres (7.0 km^2) of foundation scour protection, and 1,221 acres (4.9 km^2) of new hard protection atop cables from reasonably foreseeable environmental trends and planned actions. Of this, up to 102 foundations, 53 acres (0.21 km^2) of foundation scour protection, and 98 acres (0.5 km^2) of new hard protection atop cables would result from Alternative A, and the remainder is the estimated result of other offshore wind projects in the geographic analysis area for commercial fisheries and for-hire recreational fishing. The total soft bottom area that would be modified is less than 0.002 percent of available soft bottom in the geographic analysis area. The total number of foundations, the amount of scour protection, and the amount of cable protection would be the same under Alternative A and under the No Action Alternative. The structures and the consequential impacts would remain at least until decommissioning of each facility is complete. In context of reasonably foreseeable environmental trends, the combined impacts from the presence of structures on commercial fisheries and for-hire recreational fishing from ongoing and planned actions, including Alternative A, would likely range from **negligible** to **major** based on the sub-IPFs identified in Table 3.10-1.

Increased vessel traffic: As described in Section 3.11.2, Alternative A would generate a small increase in vessel traffic (compared to the expanded planned action scenario), with a peak during the proposed Project construction. Offshore construction and installation of Alternative A would temporarily restrict access to the OECC route and WDA during construction. Construction support vessels, including vessels carrying assembled WTGs or WTG components, would be present in the waterways between the WDA and the ports used during Alternative A construction and installation. Alternative A would result in an average of 25 vessels operating in the WDA or OECC at any given time, with a maximum of 46 vessels (COP Volume I, Section 4.2.4; Epsilon 2020a). Fishing vessels transiting between the Alternative A ports and the WDA would be able to avoid Alternative A vessels and restricted safety zones though routine adjustments to navigation, which would be informed by Vineyard Wind's implementation of a Mariner Communication Plan and dedicated Maritime Coordinator to reduce vessel conflicts (Section 3.11.2). For the nearshore portions of the OECC, vessels not used for Alternative A may need to travel a narrower route near the OECC installation vessels due to submerged hazards and landmasses, and thus could potentially experience greater delays. All Project vessels involved in construction, operations, maintenance, and decommissioning activities would comply with U.S. and/or Safety of Life at Sea Convention standards regarding vessel construction, vessel safety equipment, and crewing practices. AIS would be installed on all Project vessels associated with construction and installation. AIS would be required to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements. Although fishing vessels may experience increased transit times in some situations, these situations are spatially and temporally limited and overall BOEM expects Alternative A vessel activities in the open waters between the WDA and ports and along the OECC to have **minor** impacts on fishing vessels.

The operations and maintenance of Alternative A would require a much more limited number of vessels than construction activities, with most vessels used for routine operations and maintenance. Further, most operations and maintenance vessels would be transiting to and from Alternative A operations and maintenance facilities located in Vineyard Haven on Martha's Vineyard, as well as at the MCT (COP Volume I, Section 3.2.6; Epsilon 2020a). Vineyard Wind would use crew transport vessels (about 75 feet [22.9 meters] in length) to transfer personnel, parts, and equipment. Service operations vessels (260 to 300 feet [79.2 to 91.4 meters] in length) have onboard crew and maintenance team quarters, shop facilities, a large open deck, appropriate lifting and winch capacity, and, in some instances, a helipad. Vineyard Wind would likely base smaller vessels in Vineyard Haven, while larger vessels would use the MCT. In a typical year, Alternative A would generate approximately 401 to 887 vessel trips per year, which could include approximately 256 to 765 crew transfer vessel trips, approximately 110 multipurpose vessel trips, and approximately 26 service operation vessel trips (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2020a). Project operations would generate an average of one to three daily vessel trips. Given this relatively low number of Project vessels trips, it is expected that the Proposed Action would have a **minor** impact on commercial and for-hire recreational fisheries. As shown on Figure 3.10-14, a majority of the 538 unique fishing vessels transit and fish in a northwest-southeast direction through the WDA. For more discussion, see Section 3.11.

In 2017, there were 4,300 federally permitted vessels operating in the Northeast across all fisheries, with up to 225 vessels (approximately 5 percent) reporting trips from the WDA (NMFS 2020a). Ongoing activities, future activities, and other future offshore wind development could incrementally impact commercial fishing vessels as more projects are developed. In context of reasonably foreseeable environmental trends, the combined impacts from increased vessel traffic on commercial fisheries and for-hire recreational fishing from ongoing and planned actions, including Alternative A, would range from **minor** to **moderate**.

Climate change: This IPF would contribute to shifting distributions of commercial and for-hire fisheries. Because this IPF is a global phenomenon, the impacts in context of reasonably foreseeable environmental trends and planned actions through this IPF would be similar to those under the No Action Alternative. Implementation of offshore wind projects would likely result in a net decrease in GHGs, and more details on this IPF can be found in Section 3.10.1.1. The intensity of impacts in context of reasonably foreseeable environmental trends and planned actions resulting from climate change are uncertain, but are likely to be **minor** to **moderate**.

Regulated fishing effort: This IPF would contribute to short-term and long-term **moderate** impacts on commercial fisheries and for-hire recreational fisheries operations, as described in detail in Section 3.10.1 and 3.10.1.1, and in Table 3.10-1. The effects of Alternative A alone with fisheries regulations would increase impacts on commercial fisheries beyond those of the No Action Alternative. However, the extent of impacts from offshore wind development on regulated fishing effort is difficult to predict. The impacts would vary depending on the fishery and the changes in fishing behavior due to offshore wind development. Fishing regulations may have less flexibility in area-based management, and offshore wind may change the distribution of fishing effort in ways not contemplated in FMPs. Additionally, impacts on fisheries scientific surveys may result in more conservative quota and effort management measures. In context of reasonably foreseeable environmental trends, the combined impacts of regulated fishing effort on commercial fisheries and for-hire recreational fishing from ongoing and planned actions, including Alternative A, would be **moderate**.

In summary, activities associated with the construction and installation, operations and maintenance, and decommissioning in the WDA and OECC would impact commercial fisheries and for-hire recreational fishing to varying degrees. Overall, vessel traffic from operations and maintenance of Alternative A would have a **minor** impact on commercial and for-hire recreational fisheries due to the number of vessels transiting the area compared to the status quo. BOEM expects the presence of structures to impact navigation as a result of Alternative A resulting in a **moderate** effect on commercial fisheries and for-hire recreational fishing. Although mitigated through voluntary gear loss compensation program, the impact of damage or loss of deployed gear as a result of operations and maintenance is expected to have a **moderate** effect on mobile gear commercial fisheries and for-hire recreational fishing due to striking or hooking on proposed infrastructure. BOEM expects the presence of structures would increase space-use conflicts and potential displacement of fishing vessels on fishing grounds as a result of Alternative A. Voluntary revenue loss compensation programs included in Alternative A could reduce the expected **moderate** to **major** impacts on commercial fisheries to **minor** to **moderate**. Impacts on for-hire recreational fishing would be **minor** to **moderate**. There would be a **minor** impact due to port utilization because of Alternative A with the estimated three vessel trips per day during regular operations. The impact of noise to commercial and for-hire recreational fishing is anticipated to be **negligible** to **minor**, primarily resulting in reduced catchability of fish in close proximity to active pile driving. The complete list of impacts from the Proposed Action is found in Table 3.10-1. Overall, BOEM anticipates the impacts resulting from Alternative A alone from all IPFs with mitigation would range from **negligible** to **moderate**. Although some of the proposed activities and/or IPFs analyzed could overlap, BOEM does not anticipate that this would alter the overall impact rating of **moderate**. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.10.1.2.

In the context of other reasonably foreseeable environmental trends, combined impacts resulting from individual IPFs from planned actions, including Alternative A, would range from **negligible** to **major**. Considering all the IPFs together, BOEM anticipates that the impacts from ongoing and planned actions, including Alternative A, would result in **major** impacts on commercial fisheries and for-hire recreational fishing in the analysis area. The financial compensation agreements outlined in Table 3.10-13 would result in a lower impact specific to Alternative A; however, these compensation measures are not currently in place for other future offshore wind projects. This impact rating is driven mostly by changes to fish distribution/availability due to ongoing climate change, reduced stock levels due to ongoing fishing mortality, and permanent impacts due to the presence of structures (cable protection measures and foundations). Alternative A would contribute to the overall impact rating primarily through permanent impacts from the presence of structures (cable protection measures and foundations), including navigation hazards, gear loss and damage, and space use conflicts. Thus, the overall impacts on commercial fisheries and for-hire recreational fishing qualifies as **major** because the fishing industry would experience unavoidable disruptions beyond what is normally acceptable, but mitigation, including financial compensation and uniform spacing and layout across adjacent projects, could reduce impacts if adopted for future offshore wind projects.

BOEM could approve a COP with one or more of the mitigation measures described above and outlined under the commercial fisheries and for-hire recreational fishing resource area (Appendix D and Table 3.10-13). These funds have been voluntarily established by Vineyard Wind to compensate for losses to commercial fisheries and for-hire recreational fishing.

- Direct Compensation Fund: Vineyard Wind has established gear loss and revenue compensation funds for fishing interests based in Rhode Island and Massachusetts totaling approximately $25.4 million over the 25-year operation term and 5-year decommissioning term of the Project. A $4.2 million direct compensation fund would be held in escrow to compensate for any claims of direct impacts on Rhode Island vessels and Rhode Island fishing interests and a similar $19.2 million fund for Massachusetts vessels and Massachusetts fishing interests.[31]
- Massachusetts Fisheries Innovation Fund: A $1.75 million fund to support grants for technology and innovation upgrades for fishery participants and vessels.
- Other States Compensation Fund: Vineyard Wind has volunteered to set aside $3.3 million[32] and establish a fund for claims of direct compensation from other affected states vessels and fishing interests.
- Rhode Island Fisherman's Future Viability Trust: A $12.5 million Trust to further the policies of the Ocean Special Area Management Plan with respect to the continued viability and success of Rhode Island's fishing industry and to support and promote the compatibility of offshore wind and commercial fishing interests within Rhode Island's geographic location description (GLD).
- Pre- and post-construction monitoring for benthic and fisheries resources to measure Project impacts on these resources.
- Fisheries monitoring surveys, to be conducted before, during, and after construction.

- Cable burial monitoring and long-term monitoring of cable placements: A post-lay cable burial assessment and remote surveys of cable placements would be conducted to confirm cables remain buried and that rock placement and concrete mattresses remain secured and undamaged.
- Daily two-way communication during construction: Vineyard Wind has proposed in their Fisheries Communication Plan establishing clear daily two-way communication channels between fishermen and the Project during construction. Vineyard Wind is responsible for ensuring this applies to contractors and sub-contractors. This would be very important for cable laying along the export cable and squid fishery in the spring and summer.
- AIS on all Project vessels and structures associated with the construction and operation of the Project: AIS would be required to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements. AIS would be required on structures per the USCG PATON permit.
- Nearshore cable lay time of year restriction: Cable laying of nearshore segments (Nantucket Sound) would occur from early September to late October (from the landfall site to the northeast portion of Martha's Vineyard) to avoid fisheries use in the spring and summer.
- DTS System: This system would monitor temperature if burial conditions have deteriorated or changed significantly and if remedial actions are warranted.
- Post-lay Cable Installation Report: The as-built cable installation report detailing burial depth and location would be provided to BOEM.

3.10.3. Consequences of Alternative C

Construction and installation, operations and maintenance, and decommissioning of Alternative C would provide more unobstructed space for navigation in the northern portion of the WDA, which is commonly used by commercial and for-hire fisheries. However, the acreage of the WDA would remain unchanged and all WTGs and ESPs would be sited within the same sized footprint as under the Proposed Action (the six northernmost WTGs would be relocated and placed along the southern portion of the WDA), and there would be no changes to ESPs or the OECC. Moving WTGs away from the northern portion could improve access to the portion of the scallop fishery that has higher vessel density in that portion of the WDA. Further, the surfclam/ocean quahog fishery was quite important in the northernmost section of the WDA. However, areas of scallop, surfclam/ocean quahog, and squid concentration vary substantially from year to year, meaning the benefits of this alternative would not be consistent over time. Therefore, BOEM anticipates Alternative C alone would have the same impact on commercial fisheries and for-hire recreational fishing as Alternative A. Overall, construction and installation, operations and maintenance, and decommissioning of Alternative C would have **moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing. With mitigation implemented (Appendix D), the impacts of this alternative could decrease from **moderate** to **major,** to **moderate**.

Although BOEM expects Alternative C would have reduced impacts on fishing vessel transit from Massachusetts and Rhode Island ports to offshore fishing grounds, in context of reasonably foreseeable environmental trends and planned actions, the impacts of Alternative C on commercial fisheries would likely be very similar to those of Alternative A as discussed in the preceding paragraphs with individual IPFs leading to impacts ranging from **negligible** to **major**. In context of reasonably foreseeable environmental trends, the overall impacts on commercial fisheries and for-hire recreational fishing of ongoing and planned actions, including Alternative C, would result in **major** impacts. This impact rating is driven mostly by changes to fish distribution/availability due to climate change, reduced stock levels due to ongoing fishing mortality, and permanent impacts due to the presence of structures (cable protection measures and foundations).

3.10.4. Consequences of Alternative D

Alternative D1 would establish a 1-nautical-mile minimum spacing between all WTGs, resulting in a 22 percent increase in the area of the WDA. Alternative D2 would result in an east-west WTG orientation with 1-nautical-mile spacing between all WTGs, rather than the Proposed Action's northwest-southeast orientation and less than 1-nautical-mile spacing. These alternatives would require a larger WDA, which would require the completion of additional pre-construction surveys, expanding on those already completed for the WDA. As the WDA would expand in the southern portion of the Vineyard Wind lease area, additional surveys could result in increased vessel activity in that area prior to construction activities, causing **minor** disruptions to fishing activities.

Both alternatives would establish a slightly wider spacing of WTGs in the WDA, causing an increase in temporary disruption to access from increased WDA area (22 percent increase in area), lengthier construction and installation time, potential decreases in accessibility to/availability of fish within the WDA as Project components would be distributed throughout a larger OCS area. The wider spacing could also cause an increase in displacement of fishing vessels as a result of the larger WDA, leading to increased conflict over other fishing grounds. However, these impacts are at least partially offset for some fisheries by the artificial reef effect associated with the infrastructure surface area (cable protection, foundations/scour protection) due to placement of the WTGs and ESPs. The wider spacing would also improve maneuverability in fishing locations and the ability of vessels to deploy mobile and fixed fishing gear given the east-west orientation (only Alternative D2) and increased spacing between the WTGs, except for some commercial fisheries in the northern portion of the WDA.

The increased spacing would not result in a substantial reduction in impacts in context of reasonably foreseeable environmental trends and planned actions, as the analysis area includes Cape Hatteras to the Gulf of Maine, but may result in extensive Project delays, as a result of required additional biological, geological, and geotechnical survey work. The impacts of Alternative D1 alone would be similar to those of Alternative A (**moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing; with mitigation implemented [see Appendix D], the impacts of this alternative could decrease from **moderate** to **major,** to **moderate**), but to a lesser degree for fishing vessels due to the increased WTG spacing and to a greater degree due to the increased overall size of the WDA.

Also, the increased size of the WDA could incrementally increase effects on vessel traffic, compared to the Proposed Action; however, some Rhode Island-based commercial fisheries groups and the Rhode Island Coastal Resources Management Council have asserted that Alternative D2 would improve maritime navigation and facilitate continued fishing operations and practices within the WDA compared to the Proposed Action due to the orientation of the turbines. The USCG in the Final MARIPARS has also recommended a layout similar to D2 for the entirety of the RI and MA Lease Areas. To the extent to which certain vessels and gear types choose to fish within wind energy arrays that may be built in federal waters offshore Massachusetts and Rhode Island, an east-west turbine orientation may slightly lessen (but not eliminate) impacts on those operators (Annie Hawkins, Pers. Comm., November 16, 2018).

While there currently is east-west traffic in the WDA, there is also northwest-southeast traffic in the northern portion of the WDA. Fishermen have stated that there is an unwritten gentlemen's agreement between mobile and fixed gear vessels where fixed gear fishermen deploy their gear in a roughly east-west direction along Loran lines whose numbers end in 0 and 5, and mobile gear fishermen tow in between in an east-west direction (Mattera 2018). This has been reflected in the polar histograms for active fishing speed position reports on Figure 3.10-15. Mobile gear fishermen avoid towing where fixed gear is deployed to avoid entanglements and damage to fishing gear, while fixed gear fishermen tend to avoid mobile gear fishing to avoid damage to pots or traps. The east-west orientation could minimize the mobile and fixed gear interactions. Alternative D2 would allow the fixed and mobile gear commercial fishing operations to continue to operate within the WDA (with modifications to gear and operations) in a manner that the commercial fishing industry can coexist with the offshore wind energy industry with only slight adjustments to traditional fishing orientation.

The impacts of Alternative D2 alone would be similar to Alternative A (**moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing; with mitigation implemented [see Appendix D], the impacts of this alternative could decrease from **moderate** to **major** to **moderate**), but potentially to a lesser degree for some fishing vessels or a greater degree for others due to the orientation of the WTGs and the increased size of the WDA. Under Alternative D2, the facility design is in an east-west alignment. There would be four lines of orientation: two allowing for directional travel 1 nautical mile wide north-south and east-west, and two allowing for 0.7 nautical mile northwest-southeast and northeast-southwest. As the VMS-based polar histograms show (Figures 3.10-14 and 3.10-15), this would be about 10 to 15 degrees offset from the predominant vessel orientation at active fishing speeds and would allow for theoretical 0.7-nautical-mile-wide transit lanes in the northwest-southeast transiting direction in the WDA. When analyzing the AIS, VMS, and submitted chart plotter images, a general pattern of east-west or northeast-southwest (following Loran line orientation) fishing activity is apparent in the WDA, especially in the southern portion (Figure 3.10-19). However, those data also show a substantial number of vessels that do not fish in an east-west direction. Many of these vessels transit in an orientation more in line with the turbine layout described in Alternative A than that described under Alternative D2. A substantial number of fishing vessels already fish in a direction other than along Loran lines or east-west, which indicates that fishing in various directions can and does occur within the WDA. RODA has stated, "spacing between turbines is likely to be more indicative of impacts to fishing activity than the orientation" (see comment 0149-005 in Appendix K). However, the layout in Alternative D2 would align with fishing patterns observed in adjacent project areas (Figure 3.10-13). If adjacent projects ultimately implement a uniform 1 x 1 nautical mile WTG spacing with east-west/north-south orientation as BOEM assumes would occur under the expanded planned action scenario for southern New England, the impacts from the presence of structures on navigation hazards would be reduced, including a reduced risk of allision or collision. The impact of the Alternative D2 is greater to transiting activity, and less impactful for fishing activity. The benefits of an east-west orientation more in line with some current fishing practices is at least partially offset by the adjustment other fishing vessels that do not operate in an east-west direction would have to make. Alternative D1 and D2 could improve maritime fishing and transit due to the increased and uniform spacing between WTGs. However, the increased WDA would also result in a larger overall footprint, which decreases facility design flexibility for future projects. As indicated in a public comment (see comment 0149-005 in Appendix K), information indicates that this would not be a benefit to a number of fishermen, as the spacing of turbines would still not be adequate for some vessels and not all vessels fish or transit in an east-west orientation.

Although BOEM expects that Alternative D1 and D2 alone would have reduced impacts on fishing due to the east-west alignment with adjacent projects and wider WTG spacing, the impacts in context of reasonably foreseeable environmental trends and planned actions of Alternative D1 and Alternative D2 on commercial fisheries and for-hire recreational fishing would likely be very similar to those of Alternative A as discussed in the preceding paragraphs with individual IPFs leading to impacts ranging from **negligible** to **major**. In context of reasonably foreseeable environmental trends, the overall impacts on commercial fisheries and for-hire recreational fishing of ongoing and planned actions, including Alternative D1, would result in **major** impacts. In context of reasonably foreseeable environmental trends, the overall impacts on commercial fisheries and for-hire recreational fishing of ongoing and planned actions, including Alternative D2, would result in **major** impacts. While some impacts would be reduced under Alternative D2 due to the uniform 1 x 1 nautical mile WTG spacing with east-west/north-south orientation, the overall rating would remain **major**. This impact rating is driven mostly by changes to fish distribution/availability due to climate change, reduced stock levels due to ongoing fishing mortality, and permanent impacts due to the presence of structures (cable protection measures and foundations).

3.10.5. Consequences of Alternative E

Alternative E allows no more than 84 WTGs, and the acreage of the WDA would likely decrease compared to the Proposed Action. There would be no change in the locations of ESPs, the OECC, or transit corridors. The spacing between each of the transit corridors would be at least the same distance as Alternative A, but could be greater. Alternative E would likely improve access to certain fishing locations and the ability of vessels to deploy fishing gear where the 16 WTGs are removed (compared to Alternative A), but only in those locations. Due to the reduced number of WTGs, Alternative E could also reduce the risk of allisions and collisions between the proposed Project-related vessels and fishing vessels, and would decrease the likelihood of damage or loss of deployed gear. IPFs associated with the installation of no more than 84 WTGs, including pile driving, would be reduced by approximately 16 percent compared to the maximum-case scenario under the Proposed Action, namely 100 WTGs. BOEM expects Alternative E to have less of an impact than Alternative A, but still an overall **moderate** to **major** impact on commercial fisheries and **minor** to **moderate** impact on for-hire recreational fishing. With mitigation implemented (Appendix D), the impacts of this alternative on commercial fisheries could decrease from **moderate** to **major,** to **moderate**.

Although BOEM expects Alternative E would have reduced impacts on commercial fisheries due to less structure to impede transit and fishing, the impacts in context of reasonably foreseeable environmental trends and planned actions of Alternative E on commercial fisheries would likely be very similar to those of Alternative A, as discussed in the preceding paragraphs, with individual IPFs leading to impacts ranging from **negligible** to **major**. In context of reasonably foreseeable environmental trends, the overall impacts on commercial fisheries and for-hire recreational fishing of ongoing and planned actions, including Alternative E, would result in **major** impacts. This impact rating is driven mostly by changes to fish distribution/availability due to climate change, reduced stock levels due to ongoing fishing mortality, and permanent impacts due to the presence of structures (cable protection measures and foundations).

3.10.6. Consequences of Alternative F

Alternative F would provide space for a vessel transit lane through the WDA, in which no surface occupancy would occur. BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. Under this alternative, BOEM is analyzing a 2-nautical-mile or a 4-nautical-mile northwest-southeast vessel transit lane through the WDA combined with any action alternative; however, this analysis focuses on the combination of Alternative F with either Alternative A or Alternative D2 layout. A minimum 4-nautical-mile transit lane was proposed by RODA in their January 3, 2020, letter to BOEM requesting the analysis of this alternative and is reflective of opinions expressed by fishermen in a series of transit workshops between September and December 2018 (RODA 2020). At those same workshops, offshore wind lessees expressed that 2 miles was a sufficient corridor width for safe navigation and lease area development (Consensus Building Institute 2018). As indicated in public comment (Long Island Commercial Fishing Association [Comment 13183-013]), some fishermen felt unobstructed transit lanes of at least 5.5 nautical miles that take the least amount of time to go from port to fishing grounds and back would provide the safest access to fishing grounds. As described in Chapter 2, BOEM assumes that in order for the proposed Project to maintain the contracted energy supply, the WTGs (and possibly an ESP) that would have been located within the transit lane would be shifted south within the lease area, while the total number of foundations would remain the same. An increase in the size of the WDA would require the completion of additional pre-construction surveys, expanding on those already completed for the WDA. This work would be completed prior to construction activities, and would consist of biological, geological, and geotechnical surveys. As the WDA would expand in the southern portion of the Vineyard Wind lease area, additional surveys could result in increased vessel activity in that area prior to construction activities, causing **minor** disruptions to fishing activities.

The impacts from the combination of Alternative F with Alternatives C, D1, D2, and E are expected to be similar to the combination with Alternative A. Alternative C would shift the six northernmost WTG positions to the southern portion of the WDA, but would not change the WTG layout in the portion of the WDA affected by the northern transit lane under Alternative F. While Alternative D1 would result in wider spacing between WTGs compared to Alternative A, this increased spacing would not meaningfully change the IPFs described above for Alternative F in combination with Alternative A. While Alternative D2 would result in wider spacing between WTGs and an east-west/north-south orientation compared to the Proposed Action, this increased spacing and orientation would not meaningfully change the IPFs described above for Alternative F in combination with Alternative A. Alternative E would result in fewer WTGs in the WDA (compared to Alternative A) and thus a smaller WDA, but would not affect WTG spacing.

As a result, while the impacts of IPFs associated with Alternative F, combined with Alternatives C, D1, D2, and E could differ from those of Alternative F combined with Alternative A, these impacts would still have overall **moderate** impacts on commercial fisheries and for-hire recreational fishing.

The primary differences between Alternative A and the combination of Alternative F and Alternative A would be the establishment of an up to 4-nautical-mile-wide transit lane through the WDA. The northern transit lane within the WDA could result in the relocation of 16 to 34 WTG placements outside the proposed transit lane, an increased extent of inter-array cables, a 12 to 61 percent increase in the size of the WDA, and an increased length of inter-array cables (depending on whether Alternative A or Alternative D2 layout is used and on the width of the transit lane). The establishment of a 2- or 4-nautical-mile-wide transit lane is intended to improve fishing vessel transit through the WDA from southern New England, primarily New Bedford, Point Judith, and Stonington to fishing areas on Georges Bank, which is demonstrated in the VMS-based polar histograms (Figures 3.10-12 to 3.10-18). A navigation study conducted by Baird examined the variability of fishing vessel transit patterns over the past 4 years and found no consistent pattern from year to year, with some vessels transiting through the WDA and others transiting north of the WDA. The study showed the difference between transiting through the WDA and transiting just to the north of the WDA to be approximately 2 nautical miles, which is equivalent to adding 15 minutes to a trip (Baird 2020).

Alternative F with the Alternative D2 layout might increase impacts on safe vessel movement and navigation as a whole by adding choke points and funneling navigation. Section 3.11.5 includes further discussion on navigation impacts. While this alternative may increase unobstructed space within the transit lane, which fishing could occur within, it is not likely to improve fishing opportunities that use a different orientation (along bathymetric contours). Expanding the WDA and shifting some activities and structures to the south-southwest would likely not impact the accessibility to, or availability of, fish within the WDA, beyond the impacts of the Proposed Action, since the number of turbines would remain the same and fishing would not be restricted within the transit lane. However, the northwest-southeast orientation of the lane does not match the predominant fishing patterns in the area (Figure 3.10-12). The addition of a transit lane could also lead to increased conflict between fishermen, if they concentrate both fishing and transit activity. There would be no restrictions on setting fixed gear in the transit lanes; however, fixed gear fishermen may choose not to set gear in the transit lanes due to the greater potential for loss or damage to gear from a higher volume of transiting vessels than would occur under Alternative D2 or Alternative A. The length of inter-array cabling would increase and would be up to 234 miles (376 kilometers), exceeding the maximum design parameter in the COP PDE of 171 miles (275 kilometers) due to the need to traverse a 2-nautical-mile or 4-nautical-mile transit lane. The cables within the WDA would likely not require cable protection measures, but there could still be temporary impacts on fishing vessel activities during cable emplacement and maintenance. The impacts of Alternative F alone on commercial fisheries and for-hire recreational fishing would be at a similar level to those of Alternative A (**moderate** impacts on commercial fisheries and for-hire recreational fishing), but slightly less due to an improvement in navigation and a slight improvement in fishing opportunity.

In considering the impacts of Alternative F among other planned actions, BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. The overall impacts of Alternative F would vary depending upon if it was selected with the Alternative A or Alternative D2 layout. Alternative F combined with any other alternative would generally facilitate transit, but not improve fishing due to the orientation of the transit lanes. Thus, while navigation to other fishing grounds outside offshore wind energy project areas may be improved, impacts on fishing within project areas may only marginally improve. The overall impacts of Alternative F in combination with Alternative A and any action alternative on commercial fisheries would likely be very similar to those of Alternative A as discussed in the preceding paragraphs with individual IPFs leading to impacts ranging from **negligible** to **major**. In context of reasonably foreseeable environmental trends, the overall impacts on commercial fisheries and for-hire recreational fishing of ongoing and planned actions, including Alternative F, would result in **major** impacts. While Alternative F in combination with the Alternative D2 layout has a lower impact rating for vessel navigational hazards due to the uniform 1 x 1 nautical mile WTG spacing with east-west/north-south orientation, the overall impact rating remains **major**. This impact rating is driven mostly by changes to fish distribution/availability due to climate change, reduced stock levels due to ongoing fishing mortality, and permanent impacts due to the presence of structures (cable protection measures and foundations).

BOEM has qualitatively evaluated the collective impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. To the extent additional transit lanes are implemented in the future outside the WDA as part of RODA's suggestion, the WTGs for future offshore wind projects may need to be located farther from shore, similar to the proposed Project under Alternative F. As a result, establishment of these additional transit lanes could result in potentially more fishing opportunity within the transit lanes, improved fishing vessel navigation, and cable-related impacts; however, it could also lead to increased conflict between fishermen due to the orientation of the transit lanes not matching the east-west fishing orientation and increased impacts on vessel movement and navigation by adding choke points and funneling navigation. If all the proposed transit lanes were implemented, one or more reasonably foreseeable offshore wind projects may not be able to deliver the expected power generation capacity and/or may no longer be commercially viable because WTGs would not be placed in the area designated by the transit lanes. As a result, the technical capacity of offshore wind power generation assumed in Chapter 1 would not be met. Specifically, assuming that all WTGs would be of 12 MW capacity, an estimated 800 foundations (784 WTGs and 16 ESPs) within the RI and MA Lease Areas would be required to meet the offshore energy demand.[33] Cumulatively, implementation of all six transit lanes with a 2-nautical-mile or 4-nautical-mile transit lane and a 1 x 1 nautical mile WTG layout would only allow space for a maximum of 903 or 737 foundations, respectively. Therefore, the total number of foundations and WTGs expected in the expanded planned action scenario would decrease. However, as with the impacts of the proposed Project under Alternative F, the other projects intersected by transit lanes may also require a larger WDA and an increased amount of cable, leading to potentially more fishing opportunity within the transit lanes, improved fishing vessel navigation, and cable-related impacts under this scenario than in the absence of the transit lanes. It could also lead to increased conflict between fishermen due to the orientation of the transit lanes not matching the east-west fishing orientation and increased impacts on vessel movement and navigation by adding choke points and funneling navigation. Section 3.11.5 includes further discussion on impacts on navigation. If in the future all six transit lanes were implemented with 2-nautical-mile transit lanes and/or with the Alternative A layout, there may not be enough space to develop power generation capacity to meet demand in Massachusetts, Rhode Island, and New York. Therefore, expanded planned action scenario impacts would likely fall somewhere between the overall impacts of Alternative A (or of Alternative D2) and the overall impacts of Alternative F with 4-nautical-mile transit lanes and the Alternative D2 layout. The proposed transit lanes would not intersect any wind energy area outside the RI and MA Lease Areas.

3.10.7. Comparison of Alternatives

As discussed above, the impacts associated with Alternative A do not change substantially under Alternatives C through E. While the alternatives could slightly change the impacts on commercial fisheries and for-hire recreational fishing within the WDA and there would be incremental beneficial and adverse impacts for various users for a number of the alternatives, ultimately, the same construction, operations and maintenance, and decommissioning activities would still occur, albeit at a reduced scale in some cases. While Alternative E would reduce the overall number of WTGs from 100 to 84, thus reducing the Project's footprint, the Alternative D2 layout (east-west with 1 nautical mile between turbines) and vessel transit lanes of Alternative F would be expected to further reduce potential impacts of structures on fishing and fishing vessel transits. Alternative D2 is the alternative preferred by the Rhode Island Coastal Resources Management Council. However, BOEM expects that impacts from cable emplacement and maintenance would increase with the increased distance between turbines (Alternatives D1 and D2 with and without Alternative F). Furthermore, in context of reasonably foreseeable environmental trends, impacts from ongoing and planned actions, including any action alternative, would likely be similar because the majority of the impacts of any alternative come from other future offshore wind development, which does not change between alternatives, and because the differences in impacts between action alternatives alone would not result in different impact magnitudes. See Table 2.4-1 for a comparison of alternative impacts.

3.10.8. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E with mitigation measures in Appendix D as well as Table 3.10-13. The six northernmost WTGs would be removed and instead placed along the southern portion of the WDA, therefore providing more unobstructed space for navigation in the northern portion of the WDA, which is also commonly used by commercial and for-hire fisheries, including the scallop fishery and the surfclam/ocean quahog fishery. With the east-west WTG orientation with 1-nautical-mile spacing between all WTGs and the reduced number of WTGs and associated inter-array cabling, the Preferred Alternative footprint would reduce impacts compared to Alternative A. Overall, construction and installation, operations and maintenance, and decommissioning of the Preferred Alternative would have **moderate** to **major** impacts on commercial fisheries and **minor** to **moderate** impacts on for-hire recreational fishing. With mitigation implemented (Appendix D), the impacts of this alternative could decrease from **moderate** to **major,** to **moderate**.

Overall, construction and installation under the Preferred Alternative would have **minor** impacts on commercial fisheries and for-hire recreational fishing due to the increased use of ports; **moderate** impacts on commercial fisheries, primarily through inability to fish in the WDA and OECC when construction activities are occurring; and

[33] If the WTG sizes specified in Appendix A are assumed, a total of 975 foundations would be required for the RI and MA Lease Areas.

moderate impacts on some fisheries resources in years where the resource is collocated with construction activity. However, BOEM anticipates that the use of construction disruption payments to affected fishermen would reduce impacts to **moderate**. Construction and installation of the Preferred Alternative would have **minor** to **moderate** impacts on fishing vessels and for-hire recreational fishing given Vineyard Wind's communication plans and recreational vessel operators' ability to adjust transit and fishing locations to avoid conflicts.

Overall, vessel traffic from operations and maintenance of the Preferred Alternative would have a **minor** impact on commercial and for-hire recreational fisheries due to the number of vessels transiting the area compared to the status quo. Although reduced in size from Alternative A, BOEM expects the presence of structures to impact navigation as a result of the Preferred Alternative resulting in a **moderate** impact on commercial fisheries and for-hire recreational fishing. Although mitigated through a gear loss compensation program, the impact of damage or loss of deployed gear as a result of operations and maintenance is expected to have a **moderate** impact on mobile gear commercial fisheries and for-hire recreational fishing due to striking or hooking on proposed infrastructure. Even with the layout described in Alternative D2, BOEM expects the presence of structures would still increase space-use conflicts and potential displacement of fishing vessels on fishing grounds as a result of the Preferred Alternative. Considering the revenue loss compensation programs included in the Preferred Alternative, BOEM anticipates **moderate** impacts on commercial fisheries and **minor to moderate** impacts on for-hire recreational fishing. There would be a **minor** impact due to port utilization and the Preferred Alternative's estimated three vessel trips per day during regular operations. The impact of noise on commercial and for-hire recreational fishing is anticipated to be **negligible** to **minor**, primarily resulting in reduced catchability of fish in close proximity to active pile driving. Overall, BOEM anticipates the impacts resulting from the Preferred Alternative alone from all IPFs with mitigation would range from **negligible** to **moderate**. Although some of the proposed activities and/or IPFs analyzed could overlap, BOEM does not anticipate that this would alter the overall impact rating of **moderate**. The Preferred Alternative would result in less impact on commercial and for-hire recreational fisheries than Alternative A, but the level of reduction is not significant enough to reduce the impact level based on the definitions in this document.

3.11. NAVIGATION AND VESSEL TRAFFIC

3.11.1. No Action Alternative and Affected Environment

This section discusses existing navigation and vessel traffic in the geographic analysis area for navigation and vessel traffic as described in Table A-1 and shown on Figure A.7-12 in Appendix A, and generally includes areas within 12.4 miles (20 kilometers) of the RI and MA Lease Areas, as well as ports used for construction or operation of the Proposed Action. Table 3.11-1 describes baseline conditions and the impacts, based on the IPFs assessed of ongoing and future offshore activities other than offshore wind, which is discussed below.

The coastal areas offshore Massachusetts, Rhode Island, and the rest of New England support high volumes of vessel traffic, including cargo, tanker, and other heavy vessel traffic to and from major ports in Boston and New York, as well as commercial and recreational fishing, ferries, and other recreational vessel activity. Commercial fishing vessels and recreational vessels comprise a large majority of vessel activity in the geographic analysis area for navigation and vessel traffic, although tug-and-barge, tanker, and other vessels are not uncommon. The heaviest vessel traffic in the vicinity of the WDA occurs in four primary areas: Narragansett Bay, Buzzards Bay, Nantucket Sound, and the area between Woods Hole and Vineyard Haven. The most prevalent vessel route pattern through the WDA and much of the geographic analysis area is a roughly northwest-southeast orientation (Figure 3.11-1) (COP Volume III, Appendix III-I; Epsilon 2020b). Generally, BOEM does not anticipate any substantial changes to navigation and vessel traffic patterns in the geographic analysis area over the course of the next 30 years, except in response to offshore wind development, as discussed below.[34] Navigational safety considerations include many factors such as crew alertness, vessel seaworthiness, sea conditions, and accessibility to SAR assets. As discussed below, adding construction vessels and structures such as WTGs and ESPs to open waters (as well as increased activity in port areas) can increase crew fatigue and navigational complexity, increasing allision and collision risk.

[34] The DEIS cited 2016 and 2017 vessel traffic data. A review of the 2018 and 2019 vessel traffic data shows that the prevalent vessel route pattern remains northwest-to-southeast. To be consistent with the Navigational Risk Assessment (COP Volume III, Appendix III-I; Epsilon 2020b), the baseline data included in the DEIS remain the basis for the analysis in this FEIS.

Further, the presence of structures could complicate SAR response for vessels that become imperiled by allision, collision, or other incidents.

This section discusses navigation and vessel traffic characteristics, and potential impacts on the waterways and adjacent water approaches for the area specified within the WDA, the MCT, and other port and operations and maintenance facilities. Information presented in this section draws upon the COP (Epsilon 2018a, 2019c, 2020a, 2020b), including the Revised NRA for the Project (COP Volume III, Appendix III-I; Epsilon 2020b), which was prepared to comply with guidelines in the USCG's Navigation and Vessel Inspection Circular 02-07 (USCG 2007).

Proposed Project facilities would be located within and off the coast of Massachusetts, supported by ports in Massachusetts and potentially in Rhode Island.[35] Within the WDA and the surrounding area, vessel traffic is primarily seasonal with approximately 75 percent of all annual WDA area traffic occurring between Memorial Day and Labor Day. This is primarily due to high seasonal activity by recreational vessels and commercial fishing vessels. Cargo vessel traffic is less seasonal. The coastal areas of these states support high volumes of vessel traffic. This includes cargo, tanker, and other heavy vessel traffic to and from major ports in Boston and New York (NOAA 2020k), as well as commercial and recreational fishing, ferries, and other recreational vessel activity (Sections 3.9 and 3.10). Figure 3.11-1 presents regional vessel traffic. General traffic patterns within the proposed WDA are relatively stable. Tankers, tug/tow, cargo, and passenger vessels generally stay within fairways and designated traffic lanes and do not usually traverse the proposed WDA. However, 2015 to 2019 AIS maps show that a large volume of sailing, fishing, and other unspecified vessels traverse the geographic analysis area (Northeast Regional Ocean Council 2009). In relation to the location of the transit lanes, the commercial fishing industry has generally approached the issue of vessel transit in the southern New England lease areas holistically, rather than prioritizing one route over another. RODA's February 22, 2019, comment letter on the DEIS stated that there was "no broad 'consensus' on the location nor position of reasonable transit routes throughout the large complex of New England WEAs" (RODA 2019). Each of the proposed transit lanes reflects priorities of different ports and different fisheries. Essentially, vessel traffic in the lease area is widespread and generally without concentrated areas that would absolutely necessitate transit-lane placement.

Vessel Traffic: Table 3.11-2 summarizes the number and type of vessels recorded within 10 miles (16 kilometers) of the WDA. Commercial fishing vessels and recreational vessels comprised more than 70 percent of the AIS tracks recorded in 2016 and 2017. While the area north of the WDA is highly frequented by commercial fishermen, data analysis shows that the WDA is also used by commercial fishermen engaged in activities such as transiting through the area, gillnetting, or trawling (COP Volume III, Section 4.1.7, Appendix III-I; Epsilon 2020b).

The NRA study only recorded vessels using an AIS, which is only required on commercial vessels with a length of 65 feet (19.8 meters) or longer. As shown in Table 3.11-2, some smaller recreational and fishing vessels carry an AIS; however, the NRA data likely excludes most vessels less than 65 feet (19.8 meters) long that traverse the WDA (COP Volume III, Section 2.2, Appendix III-I; Epsilon 2020b). It is likely that non-AIS commercial and recreational vessels navigate through the WDA and across the OECC. It was estimated that AIS-equipped vessels may represent between 30 and 50 percent of the total fishing fleet (COP Volume III, Appendix III-I; Epsilon 2020b). Raw VMS data at the individual trip level were not available for analysis in the NRA. The NRA includes observations about VMS data, based on maps of 2006 to 2016 VMS data provided by NMFS and the Northeast Regional Ocean Council (NROC). These observations supplement the AIS data by identifying areas of fishing vessel concentration within the WDA and surrounding area. The VMS maps in the NRA include vessel activity density, vessel speed, and targeted fisheries within the WDA and surrounding area.[36] The analysis is generally consistent with the AIS data analysis summarized here (COP Volume III, Appendix III-I; Epsilon 2020b). The VMS data analysis presented in Section 3.10.1 is also consistent with the AIS data analysis.

Between 2016 and 2018 (inclusive), there was an annual average of 34,035 vessel crossings of the OECC. This includes an annual average of 21,455 crossings near the mouth of Lewis Bay and 9,591 crossings between Martha's

[35] Vineyard Wind could use ports in New Jersey or Canada; however, these areas are outside the scope of this analysis and Vineyard Wind is not proposing any improvements at the New Jersey port, so this section does not further discuss them.

[36] Full or part-time multispecies, scallop, monkfish, surfclam/ocean quahog, herring, mackerel, and squid/butterfish are required to have an operational VMS unit per 50 C.F.R. §§ 648.9 and 648.10.

Vineyard and the Cape Cod coast (Appendix G; Epsilon 2019a). About 15 nautical miles offshore, the OECC route would cross a navigation route for tug-and-barge (shown as "towing"), tanker, and fishing vessels. Recreational vessels have also been commonly recorded throughout this area (COP Volume III, Figure 4.0-4, Appendix III-I; Epsilon 2020b). It is likely that non-AIS commercial fishing and recreational vessels navigate across the OECC. In 2016 and 2017, a daily average of 150 vessels crossed or came within 0.3 mile (0.5 kilometer) of the OECC (COP Volume III, Section 4.3, Appendix III-I; Epsilon 2020b).

The trackline study in the NRA, which used samples of VMS and VTR fishing activity data, shows that about 80 percent of trawlers smaller than 65 feet in length were transiting through the WDA, rather than fishing in it (COP Volume III, Appendix III-I; Epsilon 2020b). The most prevalent vessel route pattern through the WDA is a roughly northwest-southeast orientation. While the area north of the WDA is more highly frequented by commercial fishermen, the data analysis showed that the WDA itself is also used by commercial fishermen engaged in activities such as transiting through the area, gillnetting, or trawling. Section 3.9 discusses recreation while Section 3.10 discusses commercial fisheries.

The heaviest vessel traffic in the WDA vicinity occurs in four primary areas: Narragansett Bay, Buzzards Bay, Nantucket Sound, and the area between Woods Hole and Vineyard Haven. Additionally, high-volume passenger ferry traffic occurs between Hyannis and Nantucket and Martha's Vineyard. Additional information and datasets, tables, and figures related to vessel traffic can be found in COP Section 7.8 (Volume III; Epsilon 2020b) and in the NRA (COP Volume III, Section 4.0, Appendix III-I; Epsilon 2020b). Section 3.3.1 provides information about passenger ferries and Section 3.10.1 provides economic information related to commercial fisheries.

Aids to Navigation: PATON and federal aids to navigation (ATON), including radar transponders, lights, sound signals, buoys, and lighthouses are located throughout the waters and coastlines surrounding the proposed Project. These aids serve as a visual reference to support safe maritime navigation. USCG operates and maintains the ATONs. The closest buoys to the WDA include a red and white bell buoy[37] (chart designation 15355) near the southern entrance to Muskeget Channel and one green can buoy[38] (chart designation 15350) that indicates the narrow channel clearance where Muskeget Channel narrows before leading into Nantucket Sound from the south. These ATONs are located approximately 4.6 nautical miles from the northern edge of the WDA. The USCG administers the permits for PATONs on structures positioned in or near navigable waters of the United States.

Navigational Safety: The NRA provides USCG data for historical SAR incidents between Block Island, Rhode Island, and the WDA—an area encompassing approximately 1,350 square miles (3,496 km^2)—from June 2006 through September 2016. During this period, USCG carried out 103 SAR missions in this region. Most of the reported incidents were related to equipment problems or failure (e.g., loss of engine power), medical issues, vessels taking on water, collision, capsizals, or disoriented vessels. Of the 103 reported incidents, approximately 43 percent occurred at night and 57 percent during daytime hours. Four of the reported incident cases were collision, although none of the reported collisions were within a 10-nautical-mile radius of the WDA (COP Volume III, Appendix III-I; Epsilon 2020b). Collisions in or near the WDA did not result in any deaths.

The NROC, the USCG First District, and marine trade associations conducted the Northeast Recreational Boater Survey in 2012 to characterize marine recreational boater activity in New England. The survey collected feedback from over 12,000 owners of state-registered and federally documented vessels, including pleasure craft, commercial fishing, towing, and coastwise trade vessels in New England (Starbuck and Lipsky 2013). According to the survey, New England boaters have an average of 30 years of boating experience, with over 65 percent of participants having previously completed navigational classes (Starbuck and Lipsky 2013). More than 58 percent of the 12,000 recreational boaters surveyed by NROC stated it was "very or somewhat likely" that they could continue to enjoy recreational boating near offshore wind turbines (Starbuck and Lipsky 2013). The most common concerns identified by recreational boaters regarding allision and collision safety were "fellow boaters' behavior," "inconsiderate actions by others" (74 percent), "lack of knowledge of navigation rules by others" (58 percent), and "use of alcohol by boat operators" (43 percent) (Starbuck and Lipsky 2013).

[37] Red and white buoys mark the center of channel, fairways, and offshore approach points, and indicate unobstructed water on all sides.

[38] A green can buoy marks the right (starboard) side of the channel when leaving a harbor toward open waters.

As discussed in Section 2.1.3.2, in September 2018, the Massachusetts Fisheries Working Group on Offshore Wind and USCG identified a 2-nautical-mile-wide, northwest-southeast oriented, navigational safety corridor south of the WDA. Subsequent to that meeting, the USCG began preparing the MARIPARS to evaluate the need for establishing vessel routing measures to enhance navigational safety (84 Fed. Reg. 11314 [March 26, 2019]). USCG's Final MARIPARS, published in May 2020, evaluated vessel traffic through the lease areas and recommended all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would have approximately 1-nautical-mile-wide lanes available when traveling north-south or east-west, and 0.6- to 0.8-nautical-mile-wide lanes when traveling northwest-southeast or northeast-southwest (USCG 2020b). The Final MARIPARS did not recommend implementation of a wider transit lane.

Ports, Harbors, and Navigation Channels: The major ports in the vicinity of the proposed WDA include ProvPort, Fall River, New Bedford, and Davisville. These ports serve the commercial fishing industry (Section 3.3.5), passenger cruise lines, cargo, and other maritime activities. Of these, the largest deep draft port by volume is ProvPort (COP Volume III, Section 4.1, Appendix III-I; Epsilon 2020b). The primary vessel traffic and commercial shipping lanes to these ports are outside the WDA (COP Volume IIL, Section 5.5.1, Appendix III-I; Epsilon 2020b). Section 3.3.1 discusses economic activity at these ports.

Total vessel transits in the Vineyard Wind 1 Project area have remained relatively stable since 2010. Figure 3.11-2 presents vessel traffic in ports that would be affected by the Proposed Action. Between 2010 and 2016, cargo tonnage at area ports increased by 21.7 percent, while cargo vessel transits decreased by over 60 percent, reflecting increasing cargo vessel capacities. Memorial Day to Labor Day activity comprised 60 percent (2016) and 38 percent (2017) of total annual cargo vessel trips in the WDA and surrounding area (COP Volume III, Section 4.1, Appendix III-I; Epsilon 2020b).

Traffic patterns in the vessel traffic routes within the geographic analysis area are relatively stable (Northeast Regional Ocean Council 2009); however, vessel size, and vessel traffic volume and density in the geographic analysis area could be affected by coastal developments, market demands, and other factors (Northeast Regional Planning Body 2016). Tankers, tug/tow, cargo, and passenger vessels generally stay within fairways and designated traffic lanes and do not usually traverse the proposed WDA. However, 2015 to 2019 AIS maps indicate that a substantial volume of sailing, fishing, and other unspecified vessels traverse this area (Northeast Regional Ocean Council 2009).

3.11.1.1. Future Offshore Wind Activities (without Proposed Action)

BOEM expects future offshore wind activities to affect navigation and vessel traffic through the following primary IPFs.

Anchoring: Future 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 in or near the Buzzards Bay and Narragansett Bay traffic separation scheme lanes. Generally, larger vessels accidently 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, risks associated with an anchor contacting an electrified cable, and impacts to the vessel operator's liability and insurance. Impacts on navigation and vessel traffic would be temporary and localized, and navigation and vessel traffic would be expected to fully recover following the disturbance. In total, BOEM estimates approximately 126 acres (0.5 km^2) of seabed would be disturbed by anchoring associated with offshore wind activities. Considering the small size of the geographic analysis area compared to the remaining area of open ocean, as well as the likelihood that any anchoring risk would occur in an emergency scenario, it is unlikely that anchoring associated with offshore wind activities would impact navigation.

Port utilization: Future 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 New Bedford, Providence, and Davisville (Quonset Point). 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 activity could lead to increased risk of allision, collision, and vessel delay. Based on the vessel traffic generated by the Proposed Action, BOEM assumes that construction of each future offshore wind project would generate an average of 25 and a maximum of 46 vessels operating in the geographic analysis area for navigation and vessel traffic at any given time, and that each future offshore wind project would generate a daily average of 18 vessel trips during peak construction (COP Volume I; Epsilon 2020a). Up to four offshore wind projects (not including the Proposed Action) would be under construction at the same time in 2024. During this peak period, the No Action Alternative would therefore result in 100 to 184 vessels operating simultaneously, generating up to 72 vessel trips per day to and from ports in the region (assuming overlap of the peak construction periods of all four simultaneous projects). Fewer vessels would be present, and fewer trips would occur during other parts of the overall construction period (2022 to 2030) for offshore wind projects in the RI and MA Lease Areas. 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 future 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. During peak activity, impacts on port utilization would be short-term, continuous, and localized to the ports and their maritime approaches.

Presence of structures: Using the assumptions in Appendix A, the expanded reasonably foreseeable environmental trends and planned action scenario would include approximately 955 WTGs and 20 ESPs in the geographic analysis area for navigation and vessel traffic, operating for approximately 30 years. 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 ESP structures in areas where no such structures currently exist, potential compression of vessel traffic both outside and within wind development areas, potential interfere with marine vessel radars (although other navigation tools are available to ship captains), and potential difficulty seeing other vessels due to a cluttered view field. Comments on the SEIS specifically expressed concerns about the ability to use radar during adverse weather conditions when visibility is limited, especially in fog. Under certain atmospheric conditions, wind energy facilities could contribute to fog formation (Hasager et al. 2017). Based on a review of practical studies, the Final MARIPARS stated, "the USCG is not aware of an authoritative scientific study that confirms or refutes the concern that WTGs will degrade marine radar" (USCG 2020b). A study by the University of Texas (Ling et al. 2013) used modeling (but not studies of operational offshore wind facilities) to simulate the electromagnetic scattering and propagation over ocean surfaces, in order to provide a baseline evaluation of simulated electromagnetic and acoustical challenges to sea surface, subsurface, and airborne electronic systems presented by offshore wind energy facilities. This study indicated a potential for radar interference from offshore wind turbines. Specifically, using modeling, Ling et al. (2013) concluded that:

- Communications systems in the marine environment are unlikely to experience interference as the result of typical offshore wind development configurations, except under extreme proximity or operating conditions.
- Marine navigation radars and ocean monitoring high frequency sensors may experience interference under certain proximity and operating conditions as the result of typical offshore wind development configurations.
- Sensitive airborne radars may experience serious interference; however, the degree of interference may be system-specific and dependent on whether offshore wind developments are located within the operational area of the radar.
- Due to the virtual absence of noise exceeding background levels radiated underwater by wind turbines at frequencies above 1 kHz, interference with underwater acoustical systems is deemed to be unlikely at such frequencies. At frequencies below 1 kHz, the tones radiated by wind turbines may cause interference with certain acoustical systems when placed in close proximity to a wind development.

Marine radars have varying capabilities and the ability of radar equipment to properly detect objects is dependent on radar type, equipment placement, and operator proficiency. General mitigation measures such as properly trained radar operators, properly installed and adjusted vessel equipment, marked wind turbines, and the use of AIS all would enable safe navigation with minimal loss of radar detection (USCG 2020b). As stated in Table A-4 in Appendix A, BOEM assumes that all offshore wind developments would use 1 x 1 nautical mile spacing in fixed east-to-west rows and north-to-south columns. This arrangement would reduce, but not eliminate, navigational complexity and space use conflicts during the operation phases of the projects. Navigational complexity in the area would increase during construction as WTGs and ESPs are installed, would remain constant during simultaneous operations, and would decrease as projects are decommissioned and structures are removed.

Potential impacts of these conflicts include increased risk of allisions with stationary structures or vessels and collisions with other vessels, risk of damage to vessels or injury to crews; increased demand for USCG SAR operations due to the increase in allisions (and difficulty completing those operations due to the presence of WTGs); and increased risk of oil or chemical spills from collisions and allisions (Section A.8.2).

The fish aggregation and reef effects of offshore wind structures would also provide new opportunities for recreational fishing, although few recreational vessels presently travel as far from shore as the proposed offshore wind structures. 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. As stated in Section 3.4.1, some marine mammals may choose to avoid WTGs and ESPs. This could potentially increase the risk of cetacean interaction with vessels, marginally increasing the likelihood of a vessel strike outside WDAs.

Overall, the impacts of this IPF on navigation and vessel traffic would be long-term (as long as structures remain), regional (throughout the entire geographic analysis area for navigation and vessel traffic), and constant.

New cable emplacement/maintenance: Based on the assumptions in Table A-4 in Appendix A, the 975 foundations (955 WTGs and 20 ESPs) would require about 1,480 statute miles (2,381 kilometers) of inter-array and interlink cables. The length of OECC cable routes cannot be determined; however, one OECC is assumed to extend between each offshore wind project and the approximate nearest shoreline. 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 will 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 short-term, localized, and would be most disruptive during peak construction activity of the offshore wind projects starting in 2022.

Traffic: Based on the vessel traffic generated by the proposed Project, it is assumed that construction of each individual offshore wind project (estimated to last 3 years per project) would generate an average of 25 and a maximum of 46 vessels operating in the geographic analysis area for navigation and vessel traffic at any given time. 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. As shown in Table A-6 in Appendix A, this increase in vessel traffic and navigation risk would be at its peak in 2022 to 2023, when more than 300 WTGs and ESPs associated with at least four offshore wind projects (other than the Proposed Action) would be under simultaneous construction—i.e., a total of approximately 100 to 184 vessels in the geographic analysis area for navigation and vessel traffic at any given time during peak construction.[39] This increased offshore wind-related vessel traffic during construction would have 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 operational offshore wind facilities would consist of scheduled inspection and maintenance activities (an example schedule is provided in COP Volume I, Figure 4.3-1; Epsilon 2020a), with corrective maintenance as needed. Based on information for the proposed Project (COP Volume I; Epsilon 2020a), on average there would be approximately one vessel trip per day during a project's operational period. During operation, project-related vessel traffic would have long-term, intermittent, localized impact on overall vessel traffic and navigation. Vessel activity would increase again during decommissioning at the end of the assumed 30-year operating period of each project, with magnitudes and impacts similar to those described for construction.

[39] As specified in this FEIS, Section 1.7, BOEM's analysis of the reasonably foreseeable build-out scenario assumes that the potential challenges of vessel availability and supply chain will be overcome and projects will advance.

3.11.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, navigation and vessel traffic would continue to follow current regional trends and respond to current and future environmental and societal activities.

While the proposed Project would not be built as proposed under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind activities, and future 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 presence of structures, port utilization, and vessel traffic, would be **moderate**. Seafloor areas within the WDA and OECC route would remain available for future marine minerals leasing, location of future offshore energy projects, siting of future submarine cables and pipelines, and surface or submarine military vessel activity. The harbors proposed for construction or decommissioning support, or operations and maintenance would continue current operations. In addition to ongoing activities, reasonably foreseeable activities other than offshore wind may also contribute to impacts on navigation and vessel traffic. Reasonably foreseeable activities other than offshore wind include anchoring, port expansion, new cable emplacement and maintenance, and SAR operations (Table 3.11-1). BOEM anticipates that the impacts of planned actions other than offshore wind would be **negligible**. BOEM expects the combination of ongoing activities and reasonably foreseeable activities other than offshore wind to result in **negligible** impacts on navigation and vessel traffic.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area would result in **moderate** impacts. Future 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, as well as an increased likelihood of collisions and allisions, with resultant increased risk of accidental releases. In addition, the No Action Alternative would lead to the construction of approximately 957 WTGs and 20 ESPs 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.

3.11.2. Consequences of Alternative A

The following proposed Project design parameters (Appendix G) would influence the magnitude of the impacts on navigation and vessel traffic:

- The port(s) selected to support construction and installation, in addition to the MCT;
- The number of vessels utilized for construction and installation;
- The number, type, and placement of the WTGs, including the location, width, and orientation of transit corridors through the WDA and nearby navigational safety corridor(s); and
- Time of year of construction.

In July 2020, the USCG submitted a list of recommended conditions for Project authorization. These conditions include:

- Incorporation of design features related to WTG and ESP marking, shutdown procedures, safety features;
- A requirement for Vineyard Wind to provide a detailed cable burial plan and to conduct a study of the Project's interference with marine communication, navigation systems, and radar;
- Operating requirements for the Project's control center; and
- Reporting conditions, including communication with Massachusetts and Rhode Island Port Safety Forums, among other entities.

Vineyard Wind would implement these conditions, as well as other conditions identified by USCG (Appendix D). Vineyard Wind would conduct a marine radar study in 2021 to quantify the potential impacts of the proposed Project on marine radars (see Baird 2020 for additional information on this study).

Impacts from Alternative A alone would include increased vessel traffic in and near the WDA and ports used by the Proposed Action, as well as obstructions to navigation caused by Proposed Action activities. Table 3.11-4 summarizes the anticipated Project-related vessel traffic during Proposed Action construction. Nearly all construction vessel trips would originate or terminate at the MCT; however, occasional trips could use the secondary ports in the United States or Canada.

Impacts on navigation and vessel traffic would also include changes to navigation 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 3.9 addresses the Proposed Action's impacts on recreation, while Section 3.10 addresses the Proposed Action's impacts on commercial fisheries and for-hire recreational fishing.

Alternative A alone would likely result in impacts on navigation and vessel traffic. The potential impacts would partially depend on which offshore export cable route was chosen, so this analysis assumes the maximum-case scenario. All of the impacts would be adverse; overall, the impacts of Alternative A alone on navigation and vessel traffic would likely be **major,** due primarily to the increased possibility for loss of life due to maritime incidents, which would produce significant local and possibly regional disruptions for ocean users in the RI and MA Lease Areas. The most impactful IPFs would be the presence of structures, vessel traffic, and port utilization.

Port utilization: Alternative A would generate vessel traffic at the Port of New Bedford during construction (as well as potentially at Providence and Davisville) and Vineyard Haven Harbor during operations. Alternative A would generate trips by crew transport vessels (about 75 feet [22.3 meters] in length), multipurpose vessels, and service operations vessels (260 to 300 feet [79.2 to 91.4 meters] in length), with larger vessels likely based at the MCT and smaller vessels likely based at Vineyard Haven. On average, vessels transporting components from Europe either directly to the WDA or first to a U.S. port before being transported to the WDA would make approximately five round trips per month over a 2-year offshore construction schedule (Vineyard Wind 2020b). Vineyard Wind would use an existing marina facility at Vineyard Haven. The owner of this facility intends to upgrade the facility irrespective of Vineyard Wind's presence (COP Addendum, Section 1.4; Epsilon 2019a). While these improvements would temporarily impact vessel navigation in the marina, the Proposed Action would not generate those impacts. Construction of the Proposed Action would generate an average of 25 and a maximum of 46 vessels operating in the WDA or over the OECC route at any given time (COP Volume I, Section 4.2.4; Epsilon 2020a). In a typical year, the Proposed Action would generate approximately 401 to 887 vessel trips per year, which could include approximately 256 to 765 crew transfer vessel trips, approximately 110 multipurpose vessel trips, and approximately 26 service operation vessel trips, some of which would originate from Vineyard Haven (COP Volume I, Section 4.3.4, Table 4.3-2; Epsilon 2020a). On average, the Proposed Action would generate approximately one to three vessel trips per day from the MCT and/or Vineyard Haven during regular operations. Vessel traffic generated by Alternative A would constitute less than 10 percent of typical daily vessel transits into and out of the Port of New Bedford. This finding notwithstanding, broad-beamed transfer barges or installation vessels could take up as much as one-third of the width of the entry channel for the Port of New Bedford, leaving little room for other vessels to maneuver. 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. Alternative A's impacts on vessel traffic due to port utilization would be short-term, continuous, and **moderate**.

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, although these demands would likely be spread across time, and among a greater variety of ports within and outside the geographic analysis area for navigation and vessel traffic. As stated in Section 3.11.1.1, up to four offshore wind projects (including the Proposed Action) would be under construction at the same time in 2022 and 2023. During this peak period, the ongoing and planned actions, including Alternative A, would result in 100 to 184 vessels operating simultaneously, generating up to 72 vessel trips per day to and from ports in the region (assuming overlap of the peak construction periods of all four simultaneous projects). 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 future offshore wind project (including, but not limited to the ports used by the Proposed Action). It is unlikely that all projects would use the same ports; therefore, 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, in context of reasonably foreseeable environmental trends, combined port utilization impacts on navigation and vessel traffic from ongoing and planned actions, including Alternative A, would have short-term, continuous, and **moderate** impacts.

Presence of structures: Alternative A would include up to 100 WTGs and 2 ESPs, operating for approximately 30 years, within the WDA where no such structures currently exist. Presently there are no approved routing measures within the proposed Project area that would be altered by the presence of structures. Alternative A's structures would increase the risk of allision as well as collision with other vessels navigating through WTGs, could interfere with marine radars (although other navigation tools are available to ship captains), and could cause long-distance sailing races to alter course. The increased risk of allisions and collisions would, in turn, increase the risk of spills (Section A.8.2). Comments on the SEIS specifically expressed concerns about the ability to use radar during adverse weather conditions when visibility is limited, especially in fog. As stated in Section 3.11.1, under certain atmospheric conditions, wind energy facilities could contribute to fog formation (Hasager et al. 2017). Marine radars have varying capabilities and the ability of radar equipment to properly detect objects is dependent on radar type, equipment placement, and operator proficiency. As discussed in Section 3.11.1, general mitigation measures applicable to all wind development projects and vessel operators, such as properly trained radar operators, properly installed and adjusted vessel equipment, marked wind turbines, and the use of AIS all would enable safe navigation with minimal loss of radar detection (USCG 2020b). Vessel owners may need to add navigation and communication equipment to safely navigate through the offshore wind Project. Additionally, Alternative A's structures and layout (i.e., lacking 1 x 1 nautical mile spacing and not being aligned in east-west rows and north-south columns) could make it more difficult for SAR aircraft to perform operations in the lease area. The USCG would need to adjust their 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. This could lead to increased possibility for loss of life due to maritime incidents. Nearly all vessels that travel through the RI and MA Lease Areas where no structures currently exist would need to navigate with greater caution to avoid WTGs and ESPs; however, there would be no restrictions on use or navigation in the WDA. WTGs could also serve as additional aids to navigation with lighting and marking. To further enhance marine navigation safety, sound signals[40] and/or AIS transponders would be included on selected WTGs and ESPs (COP Volume III, Section 5.4; Epsilon 2020b). Many vessels that currently navigate that area would continue to be able to navigate through the WDA between the WTGs and ESPs. Vessels that exceed a height of 82 feet (25 meters) would be at risk of alliding with WTG blades (85 to 98.4 feet [26 to 30 meters] at mean higher high water), and would need to navigate around the WDA or navigate with caution through the WDA to avoid the WTGs, though vessels of this size are unlikely to transit close enough to the WTGs to be impacted by the blade sweep. Some deep draft or tug and tow vessels would also need to make relatively minor deviations farther south to avoid the array.

As discussed in Section 3.10, commercial fishing interests have expressed concerns about entanglement of fishing gear and the ability to safely navigate through the WDA with the Alternative A WTG spacing. Fishing vessels, including those involved in line, trawl, and drag fishing, would be able to work in the area; however, vessel operators would need to take the WTGs and ESPs into account as they set their courses through the WDA, and would need to take care when fishing near the WTGs and ESPs to avoid snagging fishing equipment on underwater WTG components (Epsilon 2019d). According to the AIS data, trawling vessels required 180-degree turning diameters between 0.16 nautical mile and 0.86 nautical mile in good weather and sea conditions (note that any deployed trawling equipment may have a different trajectory than the vessel it is deployed behind due to several factors including length of wire and environmental conditions—vessels may require larger turning diameters in poor weather and sea conditions) (COP Volume III, Appendix III-I; Epsilon 2020b). These diameters were found to be possible within the Vineyard Wind turbine layout, where vessels could turn either within a row of WTGs or from one row to another (COP Volume III, Appendix III-I; Epsilon 2020b). In addition, a formula from offshore wind energy facility and maritime navigation guidance developed by the Permanent International Association of Navigation Congresses found that the minimum fishing vessel channel widths of 0.33 nautical mile and 0.32 nautical mile were calculated for transiting and trawling vessels, respectively COP Volume III, Appendix III-I; Epsilon 2020b). Vessels that could continue to navigate within the WDA would still need to navigate with more caution than is currently necessary to avoid WTGs and ESPs, especially during inclement weather. Increased navigational

[40] In consultation with USCG, sound signals could include audible sound devices, such as horns, on the WTGs and ESPs.

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.

Operations and maintenance of Alternative A would likely impact marine radar on vessels near or within the WDA. Based on a review of practical studies, the Final MARIPARS stated, "the USCG is not aware of an authoritative scientific study that confirms or refutes the concern that WTGs will degrade marine radar" (USCG 2020b). However, a study by the University of Texas (Ling et al. 2013), which used modeling (but not studies of operational offshore wind facilities) to simulate the electromagnetic scattering and propagation over ocean surfaces, indicated that there is a potential for radar interference from offshore wind turbines (Section 3.11.1). Marine radars have varying capabilities and the ability of radar equipment to properly detect objects is dependent on radar type, equipment placement, and operator proficiency; however, trained radar operators, properly installed and adjusted vessel equipment, marked wind turbines, and the use of AIS all would enable safe navigation with minimal loss of radar detection (USCG 2020b). In accordance with the USCG list of conditions for Project authorization, a study to quantify the potential impacts of the Vineyard Wind 1 Project on marine radars and to identify mitigation strategies (if needed) would be carried out in 2021 (Baird 2020). This study could help with assessing impacts and potential mitigations of future offshore wind projects. The grid-array of regularly spaced WTGs could produce false and multiple radar echoes for vessels in or approaching the WDA (COP Volume III, Appendix III-I, Section 7.2.2.1; Epsilon 2020b; Appendix M in MMS 2009; de la Vega et al. 2013; Ling et al. 2013). 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 III-I, Section 5.4; Epsilon 2020b); radar is the main tool used to help locate other nearby vessels that are not otherwise visible. The navigational complexity of transiting through the WDA, including the potential effects of WTGs and ESPs on marine radars, would increase risk of collision with other vessels (including non-Project vessels and Proposed Action vessels). Further, the presence of the WTGs could complicate offshore SAR operations or surveillance missions within the WDA.

To address the operations and maintenance impacts described above, a marine coordinator would remain on duty for the life of the Proposed Action. The marine coordinator would work with the USCG to develop protocols for implementing emergency WTG shutdown in the event that USCG needs to undertake a SAR mission in the WDA. The protocol would require that blade rotation is stopped within a specified time. Communication procedures and emergency response procedures would be included in the draft Safety Management System (COP Volume III, Appendix III-I; Epsilon 2020b). Vineyard Wind would also continue to implement the Mariner Communication Plan, and would continue to coordinate with the USCG and other authorities. In addition:

- Vineyard Wind would provide lighting, high-visibility paint, reflecting panels, unique identifiers, and foghorns with a 2.3-mile (3.7-kilometer) effective radius for WTGs and ESPs. Vineyard Wind would install AIS transponders on select WTGs and ESPs, as recommended by the USCG, to promote safe navigation during limited visibility (e.g., fog or night) and adverse weather conditions. Yellow lights on the peripheral WTGs would be visible from between 2 and 5 nautical miles, while the lights on the internal WTGs would be visible at 1 nautical mile. Reflecting panels, if any, would be easily visible in the daylight, and would be made of material that can be seen at night. Fog horns are unlikely to be audible on land (COP Volume III, Appendix III-I; Section 8.2.2; Epsilon 2020b).
- Vineyard Wind would investigate providing incentives for radar software and hardware updates for non-Project vessels, as well as consultations or other training for vessel crews to help adjust radar settings and interpret radar signals (COP Volume III, Appendix III-I; Section 8.2.2; Epsilon 2020b).
- WTGs would be in a grid pattern, spaced an average of 0.86 nautical mile apart, with northeast-southwest and northwest-southeast corridors through the WDA.
- BOEM would require that all vessels comply with U.S. and/or International Convention for the Safety of Life at Sea (SOLAS) standards regarding vessel construction, vessel safety equipment, and crewing practices.
- Vineyard Wind would work with the USCG to consider any additional recommendations with respect to navigational lighting or safety, including conducting joint rescue practices between USCG and fishermen who frequent the WDA, as identified before or during construction and installation of the proposed Project.

Considering the impacts and measures described above, the structures would have localized (to the WDA), long-term, continuous, **moderate** impacts on navigation and vessel traffic. Impacts during decommissioning would be similar to the impacts described for construction and installation. Temporary disruptions of vessel traffic would occur in the immediate vicinity of the WDA while Vineyard Wind disassembles WTGs and ships them to ports for further disposal. Removal of the OECC, if required, would also generate temporary disruptions of vessel traffic. During decommissioning, Alternative A's impacts on marine radar would decline from **moderate** to **negligible**, due to the removal of WTGs that can cause radar disruptions. As with construction, decommissioning activities would have larger impacts if conducted during the summer season.

As part of the NHPA Section 106 consultation process, Vineyard Wind has proposed to not utilize the three northwesternmost turbine locations as a mitigation measure to reduce visual impacts on the Nantucket NHL. With incorporation of this measure, the number and general arrangement, as well as the size of the WDA would not change, although the elimination of the three possible turbine locations would slightly increase the area of open ocean available for navigation in the northern portion of the WDA, which is closer to ports and other shore facilities. While the significance level of the impacts would remain the same, BOEM could require this measure as a condition of COP approval, which would marginally reduce proposed Project's overall impacts on non-Project vessels.

In context of reasonably foreseeable environmental trends, structures from other offshore wind activities would generate comparable types of impacts on Alternative A, across the entire RI and MA Lease Areas, with the extent of coverage increasing as additional offshore wind projects are constructed. Large vessels headed to or from Boston or New York that occasionally transit through the WDA would also need to adjust course to avoid the Proposed Action and other proposed or reasonably foreseeable future projects. The presence of neighboring wind energy leases would further increase the navigational complexity in the region, resulting in an increased risk of collisions and allisions, which could result in personal injury or loss of life from a marine casualty, damage to boats or turbines, and oil spills. The presence of neighboring wind energy leases could also affect demand for and resources associated with USGC SAR operations by changing vessel traffic patterns and densities in the larger RI and MA Lease Areas. The layout of Alternative A's WTGs would differ from the predominant orientation of other offshore wind projects in both spacing (less than 1 x 1 nautical mile) and orientation (rows of WTGs not oriented east-west and north-south). This disparity in orientation would further hamper SAR activities and further increase navigational complexity. Additionally, USCG would need to adjust their 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. The USCG, BOEM, and Bureau of Safety and Environmental Enforcement would continue to coordinate on SAR response exercises as has been done recently on the Coastal Virginia Offshore Wind project. As a result, in context of reasonably foreseeable environmental trends, the combined impacts of presence of structures on navigation and vessel traffic from ongoing and planned actions, including Alternative A, would have regional, long-term, continuous, and **major**.

New cable emplacement/maintenance: The contribution to cable emplacement and maintenance from Alternative A alone would consist of the Vineyard Wind 1 Project's OECC and inter-array and interlink cables. The OECC would traverse 37 to 43 miles (59.5 to 69.2 kilometers), depending on the route and cable-landing site selected, while the inter-array and interlink cables would extend for about 176 linear miles (283.2 kilometers) (Chapter 2). The presence of slow-moving (or stationary) installation or maintenance vessels would increase the risk of collisions and spills and could cause long-distance sailing races to alter course, although avoidance of the entire OECC route may not be possible, depending on each race's homeport. With implementation of the mitigation measures described below and in Appendix D, Alternative A would have **moderate** impacts on sailing competitions during construction and installation. 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 localized, short-term, intermittent, **minor** impacts on navigation and vessel traffic in general.

In context of reasonably foreseeable environmental trends and planned actions, cable installation and maintenance for other offshore wind activities would generate comparable types of impacts as Alternative A for each OECC route and inter-array and interlink system. As shown in Appendix A Table A-4, OECC and inter-array/interlink cables for up to five other offshore wind projects could be under construction simultaneously. Simultaneous construction of inter-array and interlink 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/interlink system at any given time. Based on the location of other offshore wind projects and the nearest shorelines, it is unlikely that OECC routes for these projects would overlap geographically, even if they are simultaneously under construction. Substantial areas of open ocean would thus separate simultaneous OECC and inter-array/interlink installation activities for other offshore wind projects. As a result, the reasonably foreseeable environmental trends and planned action impacts of cable installation for Alternative A when combined with past, present, and reasonably foreseeable activities would have localized, short-term, intermittent, **minor** impact on navigation and vessel traffic. The reasonably foreseeable environmental trends and planned action impacts of cable maintenance during operation of Alternative A and the No Action Alternative would be localized, long-term, intermittent, and **negligible**.

Traffic: Construction of the Proposed Action would generate an average of 25 and a maximum of 46 vessels operating in the WDA or over the OECC route at any given time (COP Volume I, Section 4.2.4; Epsilon 2020a). This would include up to 16 vessels that would transit to the Project area from Europe and remain on site from 2 to 12 months. On average, vessels transporting components from Europe either directly to the WDA or first to a U.S. port before being transported to the WDA would make approximately five round trips per month over a 2-year offshore construction schedule (Vineyard Wind 2020b). On average, six cable-laying, support, and crew vessels may be deployed along sections of the OECC during the construction and installation phase (COP Volume III, Section 7.8.2.1.2; Epsilon 2020b). The presence of these vessels would increase the risk of allisions, collisions, and spills (Section A.8.2); however, vessels not associated with Alternative A would be able to avoid Proposed Action vessels, components, and access restrictions though routine adjustments in navigation. For the OECC, non-Project vessels required to travel a more restricted (narrow) lane near the OECC could potentially experience greater delays waiting for cable-laying vessels to pass. With implementation of the self-imposed measures by Vineyard Wind described below, non-Project vessels transiting between the Proposed Action ports and the WDA would be able to avoid Proposed Action vessels and any restricted safety zones (where USCG is authorized and elects to establish such zones)[41] though routine adjustments to navigation. Although fishing vessels may experience increased transit times in some situations, these situations are spatially and temporally limited. An increase in avoidance measures could lead to over-avoiding and alliding with fixed structures or non-moving vessels. During construction, Alternative A vessel traffic in ports (including the MCT and other ports identified above) would 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. Vessel traffic generated by Alternative A construction would constitute less than 10 percent of typical daily vessel transits into and out of the Port of New Bedford (COP Volume III, Appendix III-I; Epsilon 2020b), but could nonetheless restrict maneuvering room and cause delays accessing the port. Operation of Alternative A would generate one to three vessel trips per day from the MCT or Vineyard Haven to the WDA.

Section 2.3 describes the non-routine activities associated with Alternative A. Examples of such activities or events that could impact navigation and vessel traffic include non-routine corrective maintenance activities; collisions or allisions between vessels or vessels and WTGs or ESPs; 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 Vineyard Haven Harbor and in offshore locations above the OECC or within the WDA working on individual WTGs or ESPs, 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 WDA. Impacts on navigation and vessel traffic would be **moderate**, lasting only as long as severe storms or repair or remediation activities necessary to address these non-routine events.

Accordingly, Alternative A's vessel traffic would have localized, short-term, continuous, **minor** impacts on overall navigation and vessel traffic in open waters and **moderate** impacts near ports (including, but not limited to the Port of New Bedford). Operation of Alternative A would have localized, long-term, intermittent, **minor** impacts on overall navigation and vessel traffic near ports and in open waters.

In context of reasonably foreseeable environmental trends, each other offshore wind project would generate comparable amounts of vessel traffic as Alternative A, and as many as four offshore wind projects could be under construction simultaneously in 2022 to 2023. Because the ports to be used by other offshore wind projects have not

[41] The USCG's authority to establish safety zones only extends to the boundary of the territorial waters of the United States, which is 12 nautical miles from shore and outside the WDA.

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. As a result, the reasonably foreseeable environmental trends and planned action impacts of vessel traffic on overall navigation and vessel traffic at any single port in the geographic analysis area for navigation and vessel traffic would be localized, short-term, intermittent, and **minor** in open waters and **moderate** near ports. In context of reasonably foreseeable environmental trends, combined offshore wind-related vessel traffic impacts on navigation and vessel traffic from ongoing and planned actions, including Alternative A, would be localized, long-term, intermittent, and **minor**.

In summary, construction and installation, operation and maintenance, and decommissioning of Alternative A would have **negligible** to **moderate** impacts on navigation and vessel traffic. Impacts on non-Proposed Action 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 WDA, all of which would increase navigational safety risks. Some commercial fishing, recreational, and other vessels would choose to avoid the WDA altogether, leading to some potential funneling of vessel traffic along the WDA borders. Generally, fewer turbines (i.e., implementation of the larger 10 MW turbines) in the WDA would reduce potential impacts on navigation and vessel traffic. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.11.1.2.

The analysis of impacts is based on a maximum-case scenario, and if Vineyard Wind would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts, but would not likely result in different impact ratings than those described above.

In context of other reasonably foreseeable environmental trends in the area, impacts of individual IPFs resulting from ongoing and planned actions, including Alternative A, would range from **negligible** to **major**. The main IPF is the presence of structures, which increase the risk of collision/allision and navigational complexity. Considering all the IPFs together, BOEM anticipates the overall impacts on navigation and vessel traffic from ongoing and planned actions, including Alternative A, would be **major**, due primarily to the increased possibility for loss of life due to maritime incidents, which would produce significant local and possibly regional disruptions for ocean users in the RI and MA Lease Areas.

While the significance level of impacts would remain the same, to address the impacts from construction and installation, Vineyard Wind would self-implement the following measures (Appendix D):

- Establish a Marine Coordinator to "manage all construction vessel logistics and act as a liaison with the USCG, pilots, port authorities, state and local law enforcement, volunteer marine patrols, and commercial operators during construction" (COP Volume III, Appendix III-I, Section 8.1.2; Epsilon 2020b).
- Develop and frequently update a Mariner Communications Plan, which would include Notice to Mariners, a Fisheries Communications Plan (tailored to the commercial fishing industry), media announcements, inclusion of individual WTGs and ESPs on navigational charts, a website, and other methods (COP Volume III, Appendix III-I, Section 8.1.2; Epsilon 2020b).
- Work with the USCG to establish variable-size temporary safety zones in active construction areas within 12 nautical miles of the coast (depending on the nature and extent of construction activity), and to appropriately communicate those zones and other active project construction areas to mariners via Local Notices to Mariners (COP Volume III, Appendix III-I, Section 8.1.2; Epsilon 2020b).
- Develop and maintain a radio communications plan, coordinated with the USCG (COP Volume III, Appendix III-I, Section 8.1.2; Epsilon 2020b).
- Consider locating an offshore cell network or marine radio repeater stations to improve radio communications (COP Volume III, Appendix III-I, Section 8.1.2; Epsilon 2020b)—BOEM assumes that this measure would be in place for the life of the Project.
- Engage with stakeholders, including local marinas, to facilitate communication of the proposed-Project's construction schedule, and to schedule OECC installation, when possible, to avoid peak fisheries harvesting and spawning seasons (Section 3.11; COP Volume III, Appendix III-I, Section 5.2.2; Epsilon 2020b).

- Work with the marine event and sailing regatta organizers to ensure safe navigation in the WDA vicinity (COP Volume III, Appendix III-I, Section 5.2.2; Epsilon 2020b; BOEM 2019c).
- Employ additional measures in consultation with the USCG, such as the placement of temporary PATONs to minimize the risk of allision and ensure safe routes during temporary events (COP Volume III, Appendix III-I, Section 5.2.2; Epsilon 2020b).
- Work with the USCG to consider any additional recommendations with respect to navigational safety, as identified before or during construction and installation of the proposed Project.

In addition to the measures listed above, BOEM would require all construction vessels to be equipped with AIS, regardless of vessel length, and all vessels to comply with U.S. or SOLAS standards, as appropriate, regarding vessel construction, vessel safety equipment, and crewing practices. Furthermore, BOEM would require that the locations of any large boulder (which will protrude >2 meter or more on the sea floor) relocated during cable installation activities be reported to BOEM, MassDEP, Massachusetts CZM, USCG, NOAA, and the local harbormaster within 30 days of relocation.

3.11.3. Consequences of Alternative C, D1, and E

Alternative C would relocate the six northernmost WTG locations to the southern portion of the WDA, resulting in an unobstructed area in the northern portion of the WDA, which is closer to ports and other shore facilities. Alternative D1 increases the spacing between WTGs in the WDA to 1 nautical mile to reduce potential conflicts with ocean uses. Alternative E would involve construction of 57 to 84 WTGs.

All other design parameters and potential variability in design would be the same as under Alternative A. This assessment analyzes the maximum-case scenario; any potential variances in the proposed Project build-out as defined in the PDE (i.e., numbers and spacing of WTGs and ESPs, length of inter-array cable) or construction activities would result in similar or lower impacts than described below. For example, if Vineyard Wind were to use fewer, larger WTGs and less total length of cable, impacts resulting from the installation and operation of these elements would be less than the maximum described in this analysis.

The impacts of Alternatives C, D1, and E on navigation and vessel traffic are summarized below.

- The difference between Alternative C and Alternative A is the relocation of the six northernmost WTG locations to the southern portion of the WDA. The WTG locations in Alternative C would incrementally decrease impacts on vessel traffic compared to Alternative A by providing additional space closer to offshore areas more frequently used by recreational vessels. This change notwithstanding, the overall impacts of Alternative C on navigation and vessel traffic would be substantially similar, but not identical, to those of Alternative A.
- Alternative D1 would establish uniform 1 x 1 nautical mile spacing between WTGs (compared to 0.75 nautical mile with Alternative A), but would not alter the orientation of the lanes between WTGs. The total acreage of the WDA would increase by about 22 percent (an increase of 16,603 acres or 67.2 km^2). Compared to Alternative A, the increased spacing of the WTGs could incrementally decrease impacts on navigation and vessel traffic safety, compared to Alternative A, while the potentially larger footprint of the WDA would increase the geographical scope of impacts. Neither factor would change the overall impact magnitudes described for Alternative A.
- Alternative E would involve construction of 57 to 84 WTGs, each with generation capacity ranging from approximately 9.5 to 14 MW. Although Alternative E would result in 16 to 43 percent fewer structures than Alternative A, construction, installation, and decommissioning of Alternative E would have similar impacts on navigation and vessel traffic as Alternative A. During operations and maintenance, vessel operators in the WDA would still need to navigate around WTGs and ESPs. The distance between these structures could be larger and/or the size of the WDA could be smaller than under Alternative A, depending on ultimate siting locations. The increased spacing of the WTGs and/or potentially smaller footprint of the WDA could incrementally decrease impacts on navigation and vessel traffic safety, compared to Alternative A, but would not change the overall impact magnitudes described for Alternative A.

Accordingly, the impacts resulting from individual IPFs associated with Alternatives C, D1, and E on navigation and vessel traffic would be similar to those of Alternative A, but would not change the overall impact magnitudes described for Alternative A—**negligible** to **moderate**.

In context of reasonably foreseeable environmental trends, the impacts resulting from individual IPFs associated with ongoing and planned actions, including Alternatives C, D1, and E on navigation and vessel traffic, would be similar to those of Alternative A—**negligible** to **major.** Because the majority of the reasonably foreseeable environmental trends and planned action impacts of any alternative come from other offshore wind projects, and impacts of Alternative C, D1, and E alone would be very similar to those of Alternative A. The overall impacts of each alternative on navigation and vessel traffic within the geographic analysis area would be of the same level as under Alternative A—**major**, due primarily to the increased possibility for loss of life due to maritime incidents, which would produce significant local and possibly regional disruptions for ocean users in the RI and MA Lease Areas.

As described above for Alternative A, Vineyard Wind's existing commitments to mitigation measures and BOEM's potential additional mitigation measures could further reduce impacts, but would not change the impact ratings.

3.11.4. Consequences of Alternative D2

Alternative D2 would result in 1 x 1 nautical mile spacing between WTGs, with WTGs arranged in east-to-west rows and north-to-south columns, matching the orientation that BOEM assumes for all other future offshore wind projects. Alternative D2 would also result in a 22 percent larger WDA (an increase of 16,603 acres or 67.2 km^2). Due to the matching orientation, these changes would reduce navigational complexity for vessel traffic, leading to a decrease in impacts on navigation and vessel traffic safety, compared to Alternative A. The larger WDA in this alternative could incrementally increase impacts on navigation and vessel traffic safety. However, the regular and predictable layout would increase navigational safety by allowing vessel operators to set predictable courses, and by allowing the USCG to set predictable SAR patterns and successfully complete more SAR missions, thus avoiding fatalities that might otherwise occur with Alternative A or other WTG layouts. The USCG's Final MARIPARS evaluated vessel traffic through the lease areas and recommended all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would have approximately 1-nautical-mile-wide lanes available when traveling north-south or east-west, and 0.6- to 0.8-nautical-mile-wide lanes when traveling northwest-southeast or northeast-southwest (USCG 2020b). Alternative D2 is consistent with the recommendations in the Final MARIPARS. Evaluated holistically, these changes would provide a more predictable, consistent, and accessible layout for SAR activities, thus improving (compared to Alternative A and other alternatives) SAR response and success. Therefore, the impacts resulting from individual IPFs associated with Alternative D2 alone are expected to result in **negligible** to **moderate** impacts on navigation and vessel traffic.

In context of reasonably foreseeable environmental trends, impacts resulting from individual IPFs associated ongoing and planned action impacts, including Alternative D2, on navigation and vessel traffic would be **negligible** to **moderate**. This is mainly due to the coordination of the Alternative D2 WTG layout with layouts of adjacent future offshore wind projects, reducing navigational complexity as well as improving USCG SAR response, compared to Alternative A and other alternatives. The overall impacts of Alternative D2 on navigation and vessel traffic within the geographic analysis area would be lower than under Alternative A—**moderate**—due to improved SAR access and reduced loss of life. These impact ratings are driven by the construction, installation, and presence of offshore wind structures, and the increased risk of vessel allision and collision.

As described above for Alternative A, Vineyard Wind's existing commitments to mitigation measures and BOEM's potential additional mitigation measures could further reduce impacts, but would not change the impact ratings.

3.11.5. Consequences of Alternative F

Alternative F analyzes a vessel transit lane through the WDA, in which no surface occupancy would occur. The WTGs that would have been located within the transit lane would be shifted to locations south within the lease area. BOEM assumes for the purposes of this analysis that the northern transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through lease areas OCS-A 0520 and OCS-A 0521 and northwest through lease area OCS-A 0500. Under this alternative, BOEM is analyzing a 2- and 4-nautical-mile northwest-southeast vessel transit lane through the WDA combined with any action alternative; however, this analysis focuses on the combination of Alternative F with either Alternative A or Alternative D2 layout. Although the 1-nautical-mile rows and columns between WTGs under Alternative D2 could be considered transit lanes, the analysis of this alternative focuses on the 2- and 4-nautical-mile transit lanes described in Chapter 2. The Alternative D2 layout was selected because it matches the RI and MA Lease Area developers' agreement, and is the only layout among the action alternatives that includes both 1 x 1 nautical mile WTG spacing and east-west rows/north-south columns (matching the layout that BOEM assumes for other future offshore wind projects). According to RODA (2019), the transit lane through the WDA was requested "particularly in foul weather when steaming through the shallower area to the northeast of the lease areas poses greater navigational risk." This transit lane would be primarily beneficial to vessels originating from New Bedford, Stonington, and Point Judith for transiting to offshore fishing grounds on Georges Bank east of the current lease areas.

The number of the Project's WTGs installed under Alternative F would remain the same, regardless of layout. The northern transit lane within the WDA could result in the relocation of 16 to 34 WTG placements south of the WDA, an increased extent of inter-array cables, and a 12 to 61 percent increase in the size of the WDA, depending on whether Alternative A or Alternative D2 layout is used and whether the 2- or 4-nautical-mile transit lane is used (Section 2.1.5).

Regardless of layout or transit lane width, transit lanes may cause funneling of transiting traffic and may create choke and intersection points. If all transiting vessels prefer to move through the transit lanes, this would cause denser rather than dispersed traffic. This funneled traffic would also result in space use conflict if any commercial or recreational fishing activity occurs in the transit lanes. Transit lanes may also require development of more isolated lease areas than anticipated, potentially resulting in standalone locations with only a few turbines. This would cause a further rerouting south of deep-draft and tug and towing vessels that would otherwise avoid the areas.

As cooperating agencies, BOEM and the USCG consulted over the course of the NEPA process for the proposed Project as it relates to navigational safety and other aspects. The Final MARIPARS report evaluated vessel traffic through the lease areas and recommended all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would pass one WTG on either side every 1 nautical mile when traveling north-south or east-west, and every 0.6 to 0.8 nautical mile when traveling northwest-southeast or northeast-southwest (USCG 2020b). In response to concerns of increased navigational safety risks due to all transiting traffic being funneled into a navigational safety corridor or the need for wider transit lanes, the USCG stated that "the standard and uniform [1-nautical-mile] grid pattern… should alleviate… concerns [with compression and funneling traffic through relatively narrow lanes] by providing vessels with sufficient spacing and multiple options to transit safely through the array. If the entire MA/RI WEA is developed consistent with such a grid pattern, mariners could choose among the many resulting navigation safety corridors to safely navigate through the entire MA/RI WEA" (USCG 2020b). The impacts of Alternative F alone on navigation and vessel traffic would vary based on the width of the transit lane and the underlying layout used, as discussed below.

The primary differences between Alternative A and the combination of Alternative F and Alternative A would be the establishment of an up to 4-nautical-mile-wide transit lane through the WDA resulting in the following change in impacts, compared to Alternative A:

- Reduced impacts related to structures and vessel collisions, due to the presence of a transit lane approximately parallel to (or crossing perpendicularly) the approximate predominant orientation of WTGs (larger turning diameters would be required in poor weather and sea conditions, and to account for trawling equipment).
- An increased affected area due to expansion of the overall area where WTGs would be installed, where no such structures currently exist.
- Transit lanes may also cause funneling of transiting traffic and may create choke and intersection points. If all transiting vessels prefer to move through the transit lanes, this would cause denser rather than dispersed traffic. This funneled traffic would also result in increased space use conflict if any commercial fishing activity occurs in the transit lanes.
- Because mariners would not be required to use the transit lanes, and because active fishing would not be restricted within the transit lanes, simultaneous with transiting traffic, the implementation of transit lanes could increase the risk of allision or collision (and resultant spills).

None of the differences listed above, and neither transit lane width analyzed (2 or 4 nautical miles wide) would change the overall **moderate** impact of Alternative F alone on navigation and vessel traffic from the presence of structures, as described for Alternative A. The addition of a transit lane, regardless of width, would not change the individual IPFs for Alternative F in combination with Alternative A. As a result, the range of impacts of Alternative F alone for these IPFs would remain the same as or substantially similar to those of Alternative A, and would have **negligible** to **moderate** impacts on navigation and vessel traffic.

In context of reasonably foreseeable environmental trends, impacts from ongoing and planned actions, including Alternative F with Alternative A layout, would be very similar to the reasonably foreseeable environmental trends and planned action impacts under Alternative A, with individual IPFs leading to impacts ranging from **negligible** to **major** impacts on navigation and vessel traffic. The overall impacts of Alternative F with Alternative A layout, on navigation and vessel traffic would be of the same level as under Alternative A—**major**, due to reduced SAR success and the resultant increased possibility for loss of life.

The impacts from the combination of Alternative F with Alternatives C, D1, and E are expected to be similar to the combination with Alternative A. Alternative C would shift the six northernmost WTG positions to the southern portion of the WDA, but would not change the WTG layout in the portion of the WDA affected by a northern transit lane under Alternative F. While Alternative D1 would result in wider spacing between WTGs compared to Alternative A, this increased spacing would not meaningfully change the IPFs described above for Alternative F in combination with Alternative A. Alternative E would result in fewer WTGs in the WDA (compared to Alternative A) and thus a smaller WDA.

As a result, while the impacts of IPFs associated with Alternative F, combined with Alternatives C, D1, and E could differ from those of Alternative F combined with Alternative A, these impacts would still have **negligible** to **moderate** impacts on navigation and vessel traffic, resulting in overall **major** reasonably foreseeable environmental trends and planned action impacts, due to an increased possibility for loss of life from the presence of structures.

While the presence of the northern transit lane would facilitate travel for vessels seeking passage through the entire WDA, as well as collectively for vessels passing through the combined lease areas, the Final MARIPARS stated that WTGs with 1-nautical-mile spacing and north-south/east-west orientation (i.e., the Alternative D2 layout) would facilitate traditional fishing methods (east-to-west travel) in the area, would allow vessels to transit (northwest-to-southeast travel) in accordance with the International Regulations for Preventing Collisions at Sea 1972 (COLREGS), and would provide the USCG with adequate SAR access (north-to-south travel) (USCG 2020b). Establishment of a northern transit lane through the Alternative D2 layout under Alternative F would result in the following impacts on navigational safety that differ from Alternative A or Alternative D2 alone:

- Although the presence of a northern transit lane could facilitate travel for vessels seeking to pass through the entire WDA and adjacent lease areas, it is still likely that some commercial and recreational fishing and boating could occur within the RI and MA Lease Areas, including active fishing within the transit lane.
- The traditional fishing and transiting orientation and the orientation of rows between WTGs in the Alternative D2 layout (i.e., east-to-west) differs from the northwest-southeast orientation of the northern transit lane under Alternative F, and may cause use conflicts within the transit lanes (Sections 3.9.2 and 3.10.2).
- As described in Section 3.11.4, the Alternative D2 layout would allow vessel operators to set predictable courses, and would allow the USCG to set predictable SAR patterns and successfully complete more SAR missions. Furthermore, this layout would be consistent with the recommendations in the Final MARIPARS (USCG 2020b).

Due to the safety advantages of the Alternative D2 layout, the overall magnitude of the impacts on navigation and vessel traffic under Alternative F with the combination of the Alternative D2 layout would be **negligible** to **moderate**. Impacts from other IPFs under Alternative F in combination with Alternative D2 would remain the same as or substantially similar to those of Alternative D2 because the addition of a transit lane, regardless of width, would not change the other IPFs. As a result, the impacts of Alternative F in combination with the Alternative D2 layout would have **negligible** to **moderate** impacts on navigation and vessel traffic.

In context of reasonably foreseeable environmental trends in the area, impacts of individual IPFs resulting from ongoing and planned actions, including Alternative F in combination with the Alternative D2 layout would be **negligible** to **moderate**. This impact rating is primarily driven by the construction, installation, and presence of offshore wind structures, and the increased risk of vessel allision and collision. The overall impacts of Alternative F in combination with the D2 layout on navigation and vessel traffic would be **moderate**, due to improved SAR operations and reduced loss of life (as compared to Alternative F combined with Alternative A layout or other action alternatives).

Different transit lane widths would not change the list of IPFs affecting navigation and vessel traffic, but would emphasize different aspects of the IPFs and associated sub-IPFs listed in Table 3.11-1. A 2-nautical-mile transit lane would result in greater traffic density within the transit lane than a 4-nautical-mile lane (i.e., by compressing the same traffic volumes into a narrower lane) and less maneuvering space, leading to a greater chance of collision or allision with structures or stationary vessels. Due to its smaller size, commercial and recreational fishing vessels could more easily avoid active fishing within the 2-nautical-mile transit lane, thus reducing potential space conflicts within the 2-nautical-mile transit lane. By comparison, fishing vessels would be more likely to conduct active fishing within the 4-nautical-mile lane due to the larger area it comprises. This would increase the likelihood of an allision or collision, thereby increasing navigational safety risks. The 4-nautical-mile transit lane would also take longer to cross, but the lower traffic density (compared to the 2-nautical-mile width) would better enable traffic navigating along the transit lane to avoid crossing traffic.

Overall, the 2- or 4-nautical-mile transit lanes analyzed would not meaningfully change the reasonably foreseeable environmental trends and planned action impact magnitudes described above for Alternative F combined with the layout for Alternative A or Alternatives C, D1, or E (**major** overall impacts on navigation and vessel traffic) or for Alternative F combined with the Alternative D2 layout (**moderate** overall).

BOEM has qualitatively evaluated the reasonably foreseeable environmental trends and planned action impacts of implementing all six RODA-recommended transit lanes, including the northern transit lane described for Alternative F, as well as five other transit lanes through the RI and MA Lease Areas. The reasonably foreseeable environmental trends and planned action impacts on navigation and vessel traffic from implementation of all six transit lanes would be an overall increase in impacts from allisions and collisions. As discussed above, the northwest-southeast transit lane orientation through the WDA would differ from the east-west orientation of the WTGs (as analyzed in the reasonably foreseeable environmental trends and planned action scenario for all reasonably foreseeable offshore wind projects) and the east-west orientation preferred by many commercial fishing interests. In addition, some commercial and recreational fishing and boating could occur within the transit lanes (Sections 3.9.2.3 and 3.10.2.3). The differing orientations of the transit lanes and WTG layout could increase navigational complexity and safety risks for vessels. To the extent that additional transit lanes are implemented in the future outside the Vineyard Wind lease area as part of RODA's suggestion, the WTGs for other future offshore wind projects may need to be located farther from shore, similar to the proposed Project under Alternative F. As a result, establishment of additional transit lanes could require vessels that would not operate within the lease areas (e.g., cargo and tanker vessels) to make longer trips for all phases of future projects, and longer timeframes for cable installation. This could result in greater impacts on navigation and vessel traffic due to increased risk of vessel allision and collision (due to the increased distance traveled), and increased threats to human health and safety.

As described above for Alternative A, Vineyard Wind's existing commitments to mitigation measures and BOEM's potential additional mitigation measures could further reduce impacts, but would not change the impact ratings.

3.11.6. Comparison of Alternatives

As discussed above, the impacts from Alternative A alone on navigation and vessel traffic are not substantially different from those associated with Alternatives C, D1, and E. Alternatives C and D1 would alter the layout of the proposed Project, but would not substantially change any of the IPFs related to navigation and vessel traffic. Alternative E would reduce the number of WTGs compared to the number of WTGs used in Alternative A and all other alternatives, but would have similar impacts on navigation and vessel traffic as Alternative A. Alternative D2 would align the proposed Project's WTGs in a 1 x 1 nautical mile, east-west grid, consistent with the Final MARIPARS recommendations and the RI and MA Lease Area developers' agreement. This would facilitate SAR activities and avoid some of the loss of life identified for other alternatives. Implementation of Alternative F with the Alternative A WTG layout would not change the magnitude of impacts described for Alternative A nor would Alternative F with the Alternative D2 layout. Furthermore, in context of reasonably foreseeable environmental trends, impacts from ongoing and planned actions, including any action alternative, would likely be very similar because the majority of impacts from any alternative come from future offshore wind development, which does not change between alternatives, and because the differences in impacts between action alternatives alone would not result in different impact magnitudes. The exception would be that Alternative D2 or Alternative F with the Alternative D2 layout would lower the overall impacts. See Table 2.4-1 for a comparison of alternative impacts.

3.11.7. Summary of Impacts of the Preferred Alternative

The Preferred Alternative is a combination of Alternatives C, D2, and E and incorporates all the mitigation measures listed in Appendix D for this resource. The Preferred Alternative would reduce potential impacts if all construction vessels are equipped with AIS, regardless of vessel length, and all vessels comply with U.S. or SOLAS standards, as appropriate, regarding vessel construction, vessel safety equipment, and crewing practices. As described in Section 3.11.2 and Appendix D, the Preferred Alternative would reduce non-Project vessel impacts through the removal of the six northernmost turbine locations, which would marginally reduce the Project's overall impacts on non-Project vessels. In addition, any large boulders (which will protrude >2 meter or more on the sea floor) relocated during cable installation activities would be reported to BOEM, MassDEP, Massachusetts CZM, USCG, NOAA, and the local harbormaster within 30 days of relocation. Implementation of the above-mentioned mitigation measures as part of the Preferred Alternative would reduce the Project's navigation and vessel traffic impacts compared to Alternative A, although these impacts would remain **minor** to **moderate**.

Compared to Alternative A, the Preferred Alternative would construct fewer WTGs within the WDA, and Vineyard Wind would use temporary safety zones around active construction areas within territorial waters of the United States (12 nautical miles from shore) and Local Notices to Mariners so that non-Project vessels could traverse areas where construction is not occurring. During operations and maintenance, vessels in the WDA would still need to navigate among WTGs and ESPs; however, the distance between these structures could be larger than under Alternative A, depending on ultimate siting locations, and this increased spacing could incrementally decrease impacts on navigation and vessel traffic safety compared to Alternative A. The Preferred Alternative would be consistent with the recommendation in USCG's Final MARIPARS that all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would have approximately 1-nautical-mile-wide lanes available when traveling north-south or east-west, and 0.6- to 0.8-nautical-mile-wide lanes when traveling northwest-southeast or northeast-southwest (USCG 2020b).

Operations and maintenance under the Preferred Alternative would have **moderate** impacts on non-Project vessels operating near or within the WDA. Based on these considerations, the impacts of construction, installation, operation and maintenance, and decommissioning under the Preferred Alternative would be similar to Alternative A, but to a lesser extent. Therefore, BOEM anticipates the Preferred Alternative would have **negligible** to **moderate** impacts on navigation and vessel traffic.

3.12. OTHER USES

3.12.1. No Action Alternative and Affected Environment

This section discusses baseline conditions in the geographic analysis area for uses of the OCS not addressed in other portions of the FEIS—military and national security uses, aviation and air traffic, cables and pipelines, radar systems, and scientific research and surveys—as described in Table A-1 in Appendix A and shown on Figures A.7-13 and A.7-4. The geographic analysis area for military and national security uses, aviation and air traffic, cables and pipelines, and radar systems is shown in Figure A.7-13. It includes airspace, surface, and subsea areas in an area roughly bounded by Montauk, New York; Providence Rhode Island; Provincetown, Massachusetts; and within 10 miles (16 kilometers) of the RI and MA Lease Areas. It includes all of the RI and MA Lease Areas, all of Cape Cod and southeastern Massachusetts, most of Rhode Island, Montauk, New York, and intervening areas of open ocean. The geographic analysis area for scientific research and surveys is shown in Figure A.7-4 and is the same as the geographic analysis area for finfish, invertebrates, and EFH. Table 3.12-1 describes baseline conditions and the impacts, based on the IPFs assessed of ongoing and future offshore activities other than offshore wind, which is discussed below. Baseline conditions for resources evaluated as "other uses" are summarized as follows.

Military and National Security Uses: Branches of the military, as well as civilian air and vessel traffic (commercial and recreational), currently use and will continue to utilize the airspace and waters in this area for operations and training. The United States Navy (Navy), the USCG, and other military and national security entities have numerous facilities in the region (Figure 3.12-1). Major onshore regional military and national security facilities include Naval Station Newport, Naval Submarine Base New London, the Northeast Range Complex/Narragansett Bay Operation Area, Joint Base Cape Cod, and numerous USCG stations (COP Volume III; Epsilon 2020b). Onshore and offshore military and national security use areas may have designated surface and subsurface boundaries and special use airspace. Military activities are anticipated to continue into the future and may include routine activities (including SAR)[42] as well as non-routine activities. Military air traffic uses the area and other government (or government-hired private) aircraft may occasionally fly over the WDA for data collection and SAR operations.

A small portion of the northwesternmost section of the WDA is located within U.S. territorial waters and airspace. The Navy and other Department of Defense branches use the airspace over and adjacent to the WDA. A portion of the WDA is within Warning Area W-105A, a block of airspace ranging from 0 to 50,000 feet (15,240 meters) AMSL, part of the Navy-managed Narragansett Bay Complex (COP Volume III, Appendix III-J; Epsilon 2020b; GlobalSecurity.org 2018). W-105A is primarily used by the USAF, specifically the 104th Fighter Wing, a unit of the Massachusetts Air National Guard, for operations above 1,000 feet AMSL, but may also be utilized by other military entities. USAF activities within W-105A include but are not limited to supersonic operations (above 10,000 feet AMSL) and release of flares and chaff down to 2,000 feet (Military Aviation and Installation Assurance Siting Clearinghouse 2020). National defense radar systems operating within the region include the Precision Acquisition Vehicle Entry/Phased Array Warning System installation at Joint Base Cape Cod and other military radars (COP Volume III, Appendix III-I; Epsilon 2020b). Military training exercises typically occur in deeper offshore waters southeast of the WDA, although military vessels transit through the WDA (COP Volume III, Epsilon 2020b).

National security and military interests will continue to use the onshore and offshore areas in the geographic analysis area. Ongoing activities could potentially affect military and national security activities if these facilities or associated vessel traffic limits maneuverability of military aircraft or vessels or affects the scope of military or national security operations. Existing stationary facilities that present allision risks act as fish aggregating devices (FADs), or pose navigational hazards include the five offshore wind turbines associated with Block Island Wind Farm, dock facilities, meteorological buoys associated with offshore wind lease areas, and other offshore or shoreline-based structures. No additional non-offshore wind stationary structures were identified within the offshore portion of the geographic analysis area, but private or commercial docks may be added close to the shoreline. Onshore facilities that may pose navigational hazards include onshore wind turbines, communication towers, and other onshore commercial, industrial, and residential structures.

No future non-offshore wind stationary structures were identified within the offshore analysis area. Onshore, development activities are anticipated to continue with additional proposed communications towers and onshore commercial, industrial, and residential developments. Eight existing submarine cables are located in the geographic analysis area, including submarine power cables between the mainland and Nantucket and Martha's Vineyard, and two cables that cross the far western side of OCS A 0487. Submarine cables would remain in current locations with infrequent maintenance continuing along those cable routes for the foreseeable future. Current and future vessel traffic in the region is described in Section 3.11. Current activities associated with offshore wind in the geographic analysis area are limited to vessels conducting site assessment surveys.

Aviation and Air Traffic: There are numerous public and private-use airports in the region. Major airports serving the region include Boston Logan International Airport, located approximately 90 miles (145 kilometers) north of the WDA, and T.F. Green Airport in Providence, Rhode Island, located approximately 65 miles (105 kilometers) northwest of the WDA. The closest public airports to the WDA are Nantucket Memorial Airport on Nantucket and Katama Airpark and Martha's Vineyard Airport, both located on Martha's Vineyard. Private airports or airstrips near the WDA are located on Tuckernuck Island and Martha's Vineyard (Trade Wind Airport). Other public and private airports and heliports are located on the mainland.

[42] While SAR occurs on an as-needed basis and thus could be considered non-routine, USCG and other entities conduct regular SAR training and perform active SAR missions frequently enough in or near the geographic analysis area that SAR is evaluated here as a routine activity.

General aviation traffic in and near the WDA is highest during the summer tourism season. In 2019, Martha's Vineyard Airport hosted nearly 38,000 aircraft operations, while Nantucket Memorial Airport hosted nearly 78,000 operations (FAA 2020). Commercial and long-distance flights typically occur at or above 18,000 feet (5,486 meters) AMSL. High-performance jet and turboprop aircraft generally follow Instrument Flight Rules routes between 3,000 and 7,000 feet (914 and 2,134 meters) AMSL. Other aircraft operate using Visual Flight Rules, which do not require designated routes or altitudes. Visual Flight Rules pilots are required to maintain a minimum 500 feet AMSL (152.5 meters) clearance from any structure or vessel (14 C.F.R. § 91.119). There are no minimum altitude restrictions over water in the absence of any structures or vessels (BOEM 2014d). The COP Aviation Impact Assessment found that more than 90 percent of existing air traffic over the WDA occurred at altitudes that would not be impacted by the WTG placements (COP Volume III, Appendix III-J; Epsilon 2020b). The FAA has authority to review proposed structures greater than 200 feet (61 meters) tall and within 12 nautical miles of the shoreline to determine whether the activity would impact safe and efficient use of navigable airspace or air navigation and communication facilities. Construction cranes, construction of turbines in port, and transport of constructed turbines to the leased areas could also necessitate FAA aeronautical studies and compliance with FAA requirements and guidelines for marking and lighting.

Air traffic is expected to continue at current levels in and around the WDA. Ongoing activities could potentially affect aviation and air traffic by introducing obstructions to airspace and altering navigational routes. Existing aboveground stationary facilities within the geographic analysis area that present navigational hazards or may potentially cause space use conflicts include the five WTGs in the Block Island Wind Farm, onshore wind turbines, communication towers, dock facilities, and other onshore and offshore structures exceeding 200 feet in height. No future non-offshore wind stationary structures were identified within the offshore analysis area. Onshore development activities are anticipated to continue with additional proposed communications towers and onshore commercial, industrial, and residential developments.

Cables and Pipelines: The coastal region of Massachusetts and Rhode Island is served by an onshore electrical grid and a network of onshore pipelines. Islands in the region, including Block Island, Martha's Vineyard, and Nantucket, are served by submarine electrical transmission cables. Several cables make landfall near Charlestown, Massachusetts, including two submarine cables that cross the far western portion of OCS-A 0487. No offshore pipelines are located within or in the region immediately surrounding the WDA or in the geographic analysis area.

Eight existing submarine cables are in the geographic analysis area. Four submarine transmission cable systems are located in Nantucket Sound that service Nantucket and Martha's Vineyard. There are no offshore pipelines that service Martha's Vineyard or Nantucket. Service to Martha's Vineyard is provided by two cables connecting the Town of Falmouth with Vineyard Haven and Tisbury through Vineyard Sound. Two cables also service Nantucket through Nantucket Sound, from Dennis Port and Hyannis Port to landfall at Jetties Beach. The proposed cable route would not cross any existing submarine cables.

Ongoing activities could potentially affect existing cables by damaging or causing service outages to existing offshore power cables, or by affecting the siting of future cables. BOEM has not identified any publicly noticed plans for additional submarine cables or pipelines; therefore, no new cable installation is reasonably foreseeable. Structures within and near the geographic analysis area that pose potential allision hazards to cable maintenance vessels include the five Block Island Wind Farm WTGs, meteorological buoys associated with offshore wind lease areas, and shoreline developments such as docks, ports, and other structures.

Radar Systems: Commercial air traffic control radar systems, national defense radar systems, and weather radar systems currently operate in the region to serve national defense, weather, and air traffic control purposes. The closest FAA Terminal Doppler Weather Radar facilities are located near Boston Logan International Airport, more than 90 miles (145 kilometers) from the WDA. The nearest NEXRAD (WSR-88D) weather system radar is located approximately 60 miles (97 kilometers) to the north of the WDA. Rutgers University maintains a series of high-frequency radars that study ocean currents as part of the Mid Atlantic High Frequency Radar Network, including installations on Nantucket, Martha's Vineyard, and Block Island (Roarty 2020). Military radar systems within the geographic analysis area include the Precision Acquisition Vehicle Entry/Phased Array Warning System installation at Joint Base Cape Cod. Other radar sites within the geographic analysis area include Boston Airport Surveillance Radar (ASR)-9, Cape Cod Air Force Station Early Warning Radar, Falmouth ASR-8, Nantucket ASR-9, North

Truro Air Route Surveillance Radar (ARSR)-4, Providence ASR-9, Riverhead ARSR-4, and Brookhaven WSR-88D (COP Volume III, Section 7.9.1.6; Epsilon 2020b). Existing radar systems will continue to provide weather, navigational, and national security support to the region. Ongoing activities could potentially affect radar systems if construction or operational activities cause interference with radar signals. WTGs in the direct line-of-sight with, or extremely close to, radar systems can cause clutter and interference, which can result in false targets, reduced radar sensitivity, decreased probability of detection, and radar tracking anomalies. Existing wind developments in the area include scattered onshore wind turbines, and five WTGs in the Block Island Wind Farm. Reasonably foreseeable non-offshore wind structures proposed for construction in the lease areas that could affect radar systems have not been identified.

Scientific Research and Surveys: BOEM assumes that research in the geographic analysis area would include oceanographic, biological, geophysical, and archaeological surveys focused on the OCS and nearshore environments, and/or resources that may be impacted by offshore wind development. Federal agencies, state agencies, educational institutions, and environmental non-governmental organizations participate in ongoing research offshore in the RI and MA Lease Areas and surrounding waters. Aerial and ship-based research includes oceanographic, biological, geophysical, and archaeological surveys, and data collected support fisheries assessments and management actions, protected species assessments and management actions, ecosystem-based fisheries management, and regional and national climate assessments, as well as a number of regional, national, and international science activities. NMFS, the Northeast Fishery Science Center, and NOAA operate or support surveys related to ecological monitoring and fisheries stock assessments in the RI and MA Lease Areas and surrounding region. These surveys are used in part to develop data that inform stock assessments and fisheries management, and influences fisheries management planning. Fisheries stock assessment surveys and ecological monitoring surveys that occur in the region include but are not limited to: the NMFS northeast bottom trawl survey, the NMFS surfclam/ocean quahog survey, the NMFS optical scallop survey, NMFS ecosystem monitoring survey, the Virginia Institute of Marine Science Scallop Dredge Survey, and the Northeast Area Monitoring and Assessment Program Survey. Specific biological surveys conducted in leased areas offshore Massachusetts include vessel-based surveys to monitor marine mammals, sea turtles, and seabirds, and North Atlantic Right Whale aerial surveys. Other activities anticipated to continue or occur within the geographic analysis area include offshore wind site assessment activities, construction of reasonably foreseeable offshore wind facilities and associated cable systems, and vessel activity related to offshore wind development. Additional scientific surveys to ascertain impacts of offshore wind development are also likely to occur. Vineyard Wind has committed resources for ongoing monitoring in the operations phase of the Proposed Action. Because offshore wind farms on the scale of the Proposed Action do not currently exist in the United States, the construction and installation, operations and maintenance, and decommissioning phases all present unique opportunities to conduct scientific research focused on the impacts of offshore wind farms on various resources.

Scientific research activities would continue into the foreseeable future, although at potentially different levels in the geographic analysis area due to ongoing research and new opportunities associated with construction and operation of offshore wind facilities such as the Proposed Action. Ongoing activities (including climate change) could potentially affect scientific research and surveys by increasing or decreasing opportunities for research or through navigation obstructions that impede research, which in turn may affect survey methodologies and data collection practices, and may increase scientific uncertainty in fish stock assessments, endangered species monitoring, and other research efforts. Stationary structures are limited in the open ocean environment of the geographic analysis area, and include meteorological buoys associated with site assessment activities, the five Block Island Wind Farm WTGs, and the two CVOW WTGs. Other lease areas within the geographic analysis area are not yet developed and are in various stages of permitting.

The DEIS analyzed the potential impacts on marine mineral extraction and other offshore energy projects. This FEIS does not analyze the impacts of reasonably foreseeable offshore wind energy projects on these resources for the following reasons.

Marine Minerals Extraction: The Proposed Action would have no impacts on marine minerals extraction. In addition, BOEM assumes that export cables associated with future offshore wind projects would avoid identified borrow areas identified through consultation with the BOEM Marine Minerals Program and USACE prior to approval of OECC routes, avoiding impacts on known borrow areas.

Offshore Energy: The DEIS analyzed potential impacts of the Proposed Action on other offshore energy projects. No reasonably foreseeable energy projects were identified in the geographic study areas shown in Figures A.7-4 and A.7-13 other than offshore wind projects. Section 3.12.5 analyzes the impact Alternative F could have on the area available for offshore development in leases OCS-A 0520, OCS-A 0521, and OCS-A 0500.

3.12.1.1. Future Offshore Wind Activities (without Proposed Action)

BOEM expects future offshore wind development activities to affect other uses through the following primary IPFs.

3.12.1.1.1. Military and National Security Uses

The wind energy areas' geographic boundaries were developed through coordination with stakeholders to address concerns of overlapping military and security uses. BOEM continues to coordinate with stakeholders to minimize these concerns as needed.

Presence of structures: Existing stationary facilities that present allision risks are limited in the open waters of the geographic analysis area and include the five offshore wind turbines associated with Block Island Wind Farm and meteorological buoys operated for offshore wind farm site assessment. Dock facilities and other structures are concentrated along the coastline. Installation of up to 775 WTGs and 20 ESPs, plus the presence of lift vessels during construction within the lease areas, would increase the risk of allision for military and national security vessels, including USCG SAR vessels. In general, deep-draft military vessels are not anticipated to transit outside of navigation channels unless necessary for SAR operations or other non-typical activities. Therefore, vessels more likely to allide with WTGs or ESPs would be smaller-draft vessels moving within and near wind installation. Deep-draft military and national security vessels near traffic separations schemes or port entrances could potentially lose power and allide with a nearby WTG. Risks would increase over time as additional wind energy facilities are built within the RI and MA Lease Areas starting in 2022 and continuing through reasonably foreseeable buildout in 2030 (Table A-4 in Appendix A). 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 by the collaborative regional layout proposed by the five Rhode Island and Massachusetts offshore wind leaseholders, which arranges WTGs 1 x 1 nautical mile apart in fixed east-to-west rows and north-to-south columns across all lease areas offshore Massachusetts and Rhode Island. This arrangement is intended to facilitate safe navigation through the RI and MA Lease Areas (Brostrom et al. 2019). As described in Chapter 2, the USCG's MARIPARS evaluated vessel traffic through the lease areas and recommended all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would pass one WTG on either side every 1 nautical mile when traveling north-south or east-west, and every 0.6 to 0.8 nautical mile when traveling northwest-southeast or northeast-southwest (USCG 2020b). The Final MARIPARS did not recommend implementation of a wider transit lane.

The installation of up to 795 foundations within the geographic analysis area could create an artificial reef effect, attracting species of interest for recreational fishing or sightseeing, resulting in vessels that may travel farther offshore than typically occurs. Recreational fishing vessel traffic would be additive to vessel traffic that already transits the leased areas, and could increase demand for USCG SAR operations near the WTGs. The USCG does not presently retain the authority to establish safety zones outside the territorial sea. Increased risk of conflict or collision risks for military and national security vessels is anticipated to be *de minimis* because military vessels are not anticipated to transit outside of navigation channels unless necessary for SAR operations or non-typical activities. Risk would gradually increase between 2022 and 2030 as offshore wind structures are installed across the RI and MA Lease Areas, and recreational fishing vessels begin to access the development area, and would decrease incrementally as projects are decommissioned and structures removed.

The addition of up to 795 foundations (including 775 WTGs) within the geographic analysis area between 2022 and 2030 would incrementally change navigational patterns and increase navigational complexity for vessels and aircraft operating in the region around wind energy projects. During construction periods between 2022 and 2030, use of stationary lift vessels in the lease areas, cranes at port locations, and vessels transporting WTGs components in transit between the two locations would further increase navigational complexity in areas immediately around these tall structures. Increased navigational complexity would increase the risk of allisions for military and national security vessels as discussed above, and for military and national security aircraft. Similar to Vineyard Wind 1

Project, it is assumed that other offshore wind operators would implement a strict operational protocol with the USCG that requires the WTGs to stop rotating within a specified time to mitigate impacts on SAR aircraft operating in the leased areas. Additionally, USCG would need to adjust their 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. Prior to construction, applicants must file Form 7460-1 (Notice of Proposed Construction) with the FAA for each individual structure exceeding 200 feet (61 meters) tall within U.S. territorial waters, which triggers a review to identify and resolve potential aviation conflicts.[43] The Department of Defense and the Department of Homeland Security (which includes the USGC) would be invited to review and comment on the filing (per Section 5-2-2(a) of FAA Order JO 7400.2M, Procedures for Handling Airspace Matters) (FAA 2019a), and BOEM assumes that this process would be utilized, in addition to any pre-permitting coordination performed by the project applicants, to identify and resolve potential conflicts with military air traffic. For example, the Bay State Wind project, which is proposed to be located in OCS-A 0500 and overlaps W-105A, received Determinations of No Hazard for WTGs up to 320 meters (1,049 feet) AMSL (FAA 2019b). Implementation of navigational lighting and marking per by FAA and BOEM requirements and guidelines would further reduce the risk of aircraft collisions. Wind energy structures (including WTGs and ESPs) would be visible on military and national security vessel and aircraft radar. It is assumed that all project operators would coordinate with relevant agencies during the COP development process to identify and minimize conflicts with military and national security operations. Navigational hazards would gradually be eliminated when structures are removed during decommissioning.

Access to active construction areas would be temporarily restricted within the RI and MA Lease Areas between 2022 and 2030. Presence of the proposed 795 foundations (including 775 WTGs) during the projects' operational timeframes would change long-term navigation patterns in and around the RI and MA Lease Areas. As multiple projects are built, changing navigation patterns could concentrate vessels around the edges of the leased areas, potentially causing space use conflicts and increasing the risk of collisions between military/national security and civilian vessels. Warning area W-105A overlies the majority of the OCS-A 0500 and all of OCS-A 0520, OCS-A 0521, and OCS-A 0522. Wind development in the lease areas developed during the No Action Alternative could have an increasing impact the USAF 104th Fighter Wing's ability to train within W-105A as construction occurs in these areas between 2022 and 2030, and a consistent impact during project operations. The USAF indicated they were willing to concur with the Proposed Action if structures can withstand daily sonic overpressures from supersonic operations, and potentially falling debris from chaff and flare, and if the USAF would not be held liable for damage to property or personnel (Military Aviation and Installation Assurance Siting Clearinghouse 2020): BOEM assumes these same concerns would apply to other projects overlapping W-105A, and would work with the USAF to identify strategies to de-conflict these concerns through conditions of COP approval. Space use conflicts would decrease during decommissioning as structures are removed.

Based on the assumptions in Appendix A, the Vineyard Wind 2, Mayflower Wind, South Fork Wind, a development by Equinor Wind, and the Bay State Wind offshore cables would be constructed within the geographic analysis area, as could cables associated with other future offshore wind farms. Of these, only Vineyard Wind 2, South Fork, and Mayflower Wind have announced plans for cable routes in the geographic analysis area; Vineyard Wind 2 would lay cable within the same OECC as the Proposed Action, South Fork plans to make landfall in the New York area, and Mayflower Wind would lay cable somewhere between Martha's Vineyard and Muskeget Island, through Nantucket Sound, making landfall somewhere on Cape Cod. Precise cable corridors are not known for any specific project, but construction timeframes would likely be staggered between 2022 and 2030. Military and national security vessels may need to navigate around temporarily active construction sites above these cable routes. While projects are operational, transmission cables would be passive structures located on the seafloor, and would only potentially impact military and national security operations during very infrequent cable maintenance events. The Navy has raised concerns about impacts on naval operations from deployment of distributed acoustic sensing (DAS) technology through fiber optic cables in the submarine cable system (Military Aviation and Installation Assurance

[43] After conducting aeronautical studies for the WTGs in territorial waters with tip heights of 696 feet, the FAA concluded that the WTGs would have no substantial adverse effect on air navigation. Vineyard Wind would be required to re-file Form 7460-1 for any taller WTGs within territorial waters as well as construction cranes or vessels transiting between port and the WDA transporting structures over 200 feet tall (COP Volume III, Section 7.9.2.1.2; Epsilon 2020b).

Siting Clearinghouse 2020). Similar to the proposed Project, it is assumed that other future offshore wind project operators would coordinate with the Department of Defense and the Navy on any proposal to use DAS.

Traffic: Vessel traffic associated with construction and decommissioning of future offshore wind facilities could cause military and national security vessels to change routes and experience congestion and delays in port and within vessel transit routes. Wind energy facility operators use vessels for construction, maintenance, and decommissioning activities, with the highest vessel traffic during construction (approximately 2022 through 2030) and decommissioning. Construction periods would likely be staggered, but some overlap is possible. During construction, large vessels with limited maneuverability would deliver components of WTGs, ESPs, and associated equipment to one or more port facilities and to the WDA. These vessels would operate within restricted navigation channels or be on station during construction and installation activities. Operational traffic would occur at lower, consistent levels over the 30-year operational timeframes for each project. Current levels of vessel traffic are discussed in Section 3.11. Vessel traffic from each future offshore wind project is anticipated to be similar to the Proposed Action, and overall future offshore wind vessel activity would be most pronounced during construction and decommissioning time periods, when as many as five offshore wind projects could be under construction simultaneously. Similar to the Proposed Action, operational traffic associated with each other offshore wind project would be anticipated to be similar to existing civilian vessel traffic in the region. Risks of collisions between military vessels and offshore wind vessels would be highest during construction and decommissioning.

3.12.1.1.2. Aviation and Air Traffic

Presence of structures: Construction of future offshore wind facilities could add up to 775 WTGs with maximum blade tip heights of up to 853 feet (260 meters) AMSL to the RI and MA Lease Areas between 2022 and 2030. In addition, stationary and vessel-mounted construction cranes would be utilized in ports during construction, and WTGs are anticipated to have a temporary height of up to 328 feet (100 meters) during assembly at construction staging areas. Addition of these structures would incrementally increase navigational complexity and change aircraft navigation patterns in the region around the leased areas offshore Massachusetts and Rhode Island, 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. However, open airspace around the RI and MA Lease Areas would still be available over the open ocean, and ports utilized for offshore WTG construction would be planned and developed to accommodate tall structures. Addition of WTGs throughout the RI and MA Lease Areas would alter navigation patterns associated with nearby airports, including but not limited to Nantucket Memorial Airport. Port improvements and construction activities in or near ports may require alteration of navigation patterns at nearby airports, including but not limited to the New Bedford Regional Airport. Navigational hazards and collision risks at ports and in transit routes would be reduced as construction is completed, and all navigation hazards and collision risks would be gradually eliminated during decommissioning as offshore WTGs are removed.

All existing stationary structures would have navigation marking and lighting in accordance with FAA, USCG, and BOEM requirements and guidelines, and structures exceeding 200 feet AMSL and located within U.S. territorial waters would have been analyzed for potential impacts on air traffic at the time of construction through the review process triggered by filing Form 7460-1 (as explained in Section 3.12.2.2). Filing Form 7460-1 and compliance with FAA, USCG, and BOEM lighting and marking requirements and guidelines would be necessary for any structures exceeding 200 feet AMSL in U.S. territorial waters including WTGs, onshore construction cranes, and vessels en route between ports or located at construction staging areas. Because the WTGs would be taller than 699 feet (213 meters), low intensity aviation obstruction lights would be required at mid-tower, in addition to lights on the nacelle (COP Volume III, Section 2.2.1.1; Epsilon 2020b). At 853 feet (260 meters) AMSL, the blade tips within territorial waters would be identified as obstructions through the FAA obstruction evaluation process defined in 14 C.F.R. § 77.17(a)(1). Aeronautical studies would be conducted to evaluate potential physical or electromagnetic radiation impacts from these WTGs on the operation of air navigation facilities, including impacts on existing or proposed air navigation, communications, radar, and control systems, visual flight rules or instrument flight rule operations, airport traffic control cab views, and airport capacities (including impacts resulting from the structure when combined with the impact of other existing or proposed structures) (FAA 2019a). FAA obstacle clearance surfaces, which are level or sloping "imaginary" surfaces associated with airspace that identify the minimum required obstacle clearance (FAA 2018), are also investigated. As specified above, prior to construction, applicants for all individual structures exceeding 200 feet (61 meters) tall within U.S. territorial waters must file Form 7460-1 (Notice of Proposed Construction) with the FAA, which triggers a review to identify and resolve aviation risks through an aeronautical study. For example, the Bay State Wind project, proposed to be located in OCS-A 500, received Determinations of No Hazard for WTGs with heights up to 1,049 feet (320 meters) AMSL within U.S. territorial waters (FAA 2019b). The WTGs associated with the Bay State Wind project were found to exceed obstruction standards of 14 C.F.R. Part 77 in part due to necessary changes in minimum instrument flight altitudes or minimum obstacle clearance altitudes; however, the aeronautical study determined that the project would not have a substantial adverse effect on any existing or proposed arrival, departure, or en route IFR operations or procedures (FAA 2019b). Similar to Vineyard Wind 1 Project, it is assumed that project proponents would conduct aeronautical studies as part of a project's due diligence regardless of their position within or outside U.S. territorial waters boundaries. In addition, BOEM assumes that offshore wind project operators would coordinate with aviation interests throughout the planning, construction, operations, and decommissioning process to avoid or minimize impacts on aviation activities and air traffic. This coordination would include notification to the FAA of construction activities, and the FAA would issue Notices to Airmen for each vessel movement above a specified height along with Temporary Flight Restrictions associated with WTGs under construction in the WDA or in transit between ports and the WDA (COP Volume III, Section 7.9.2.1.2; Epsilon 2020b).

3.12.1.1.3. Cables and Pipelines

Presence of structures: Eight existing submarine cables and no pipelines were identified within the geographic analysis area. Installed WTGs and ESPs, and stationary lift vessels used during construction, that are located near the two existing submarine cables that cross OCS-A 0487 could pose allision risks and navigational hazards to vessels conducting maintenance activities on these cables. These two submarine cables are located within the area proposed for the Sunrise Wind Energy Facility, which is projected to be operational in 2024. Risk to cable maintenance vessels during construction and operation of the Sunrise Wind would be limited to infrequency of submarine cable maintenance required at any single location along existing cable routes. In addition, allision risks would be mitigated by navigational hazard marking per FAA, BOEM, and USCG requirements and guidelines, and by the 1 x 1 nautical mile spacing throughout the leased areas. Risk would decrease to zero during decommissioning as structures are removed.

Construction of future wind energy facilities would add up to 775 WTGs and 20 ESPs, along with approximately 1,482 miles (2,384 kilometers) of inter-array cables and 1,310 miles (2,108 kilometers) of OECC to the RI and MA Lease Areas between 2022 and 2030. Presence of these structures could preclude additional submarine cable development—including cables for future offshore wind facilities—from the wind development areas and require future cables to route around the leased areas. Future offshore wind cables would also have to consider the location of existing cables during routing, including the South Fork Wind, Mayflower, and the Bay Wind State offshore export cables. However, these export cables can be crossed using standard protection techniques during construction, operations, and decommissioning. During project operational timeframes, impacts on submarine cables crossed by offshore wind cables would be limited to rare occasions when maintenance work at the cable crossings would be required. Impacts on submarine cables would be eliminated during decommissioning of offshore wind farms if export cables associated with those projects are removed.

3.12.1.1.4. Radar Systems

Presence of structures: Operational onshore and offshore WTGs in the direct line-of-sight with or extremely close to radar systems can cause clutter and interference. Construction of future wind energy facilities would add up to 775 WTGs with maximum blade tip heights of up to 853 feet (260 meters) AMSL to the RI and MA Lease Areas between 2022 and 2030. NOAA NEXRAD weather radar systems are located a sufficient distance from the RI and MA Lease Areas such that radar interference and mitigation would not be anticipated (COP Volume III, Section 7.9.2.1.2, Figure 7.9-1; Epsilon 2020b). Rutgers University indicates that the operational WTGs could affect signals from the Mid Atlantic High Frequency Radar Network (Roarty 2020). Development of offshore wind projects in the RI and MA Lease Areas could incrementally decrease the effectiveness of individual military radar systems if the field of WTGs expands within the radar system's coverage area. In addition, large areas of installed WTGs within the RI and MA Lease Areas could create a large geographic area of degraded radar coverage that could impact multiple radars. The Military Aviation and Installation Assurance Siting Clearinghouse review of the Proposed Action conducted in 2020 stated that such impacts could adversely affect the North American Aerospace Defense Command's (NORAD) radar operations and defense of national critical infrastructure located in the same geographic areas (Military Aviation and Installation Assurance Siting Clearinghouse 2020). It is reasonable to assume that other offshore wind projects near the proposed Project could cause similar impacts.

The FAA would evaluate potential impacts on radar systems, as well as mitigation measures for those impacts through their review of Form 7460-1 for individual WTGs within U.S. territorial waters (as explained in Aviation and Air Traffic discussion) (FAA Order JO 7400.2M, FAA 2019a). For example, the Bay State Wind project, proposed to be located closer to ground-based radar systems than the Proposed Action, received Determinations of No Hazard for WTGs with heights of up to 1,049 feet (320 meters) AMSL. Although WTGs associated with the Bay State Wind project were found to be within the direct line-of-sight for the Falmouth ASR-8, Nantucket ASR-9, and Coventry (Rhode Island) ASR-9 radar systems, the aeronautical study determined that the Bay State Wind project's WTGs would not have a substantial adverse effect on radar operations at the time of study (FAA 2019b). BOEM assumes that each project proponents would conduct an independent radar analysis, particularly for WTGs outside of U.S. territorial waters, to identify potential impacts and any mitigation measures specific to aeronautical, military, and weather radar systems for each WTG analyzed, per BOEM-identified BMPs (Appendix A, Table A-5).[44] 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 de-conflict project concerns identified through such consultation related to military and national security radar systems with COP approval conditions—including concerns related to installation of multiple projects.

3.12.1.1.5. Scientific Research and Surveys

Presence of structures: Activities associated with offshore wind development such as site assessment activities, construction of reasonably foreseeable offshore wind farms (including placement of structures such as ESPs and WTGs), associated cable systems, and vessel activity would present additional navigational obstructions for sea and air-based scientific surveys. Using the assumptions in Table A-4 in Appendix A, construction of future wind energy facilities would add up to 775 WTGs to the RI and MA Lease Areas and 1,059 WTGs outside the New England area within the geographic analysis area between 2022 and 2030. The WTGs would have an assumed maximum blade tip height of up to 853 feet (260 meters) AMSL. Collectively, these developments would preclude continued NMFS scientific research surveys under current vessel capacities and monitoring protocols in the geographic analysis area and may reduce opportunities for other NMFS scientific research studies in the area. NMFS scientific surveys that overlap with wind development areas collectively represent over 277 survey-years of total effort by dedicated NOAA ship and aircraft resources. Data gathered from these surveys represent some of the most comprehensive data on marine ecosystems in the world, and data within offshore wind development areas are essential to those datasets in the Northwest Atlantic Ocean. These data support fisheries assessments and management actions, protected species assessments and management actions, ecosystem-based fisheries management, and regional and national climate assessments, as well as a number of regional, national, and international science activities.

Within offshore wind facility areas, survey operations would be curtailed or eliminated under current vessel capacities and monitoring protocols. Specifically, coordinators of large vessel survey operations or operations deploying mobile survey gear have currently determined activities within offshore wind facilities are not within their safety and operational limits. The need for survey vessels to navigate around large offshore wind projects to access survey stations would cause a loss of efficiency for surveys conducted outside the wind energy areas by reducing sampling time available with limited sea day allocations for survey vessels. In addition, changes in required flight altitudes due to proposed turbine height would affect aerial survey design and protocols. Stock assessment surveys for fisheries and protected species and ecological monitoring surveys considered in this analysis include, but are not

[44] As stated in BOEM's *Information Guidelines for a Renewable Energy Construction and Operations Plan*, BOEM recommends the following be included in a COP to "demonstrate that the project is being conducted in a manner that confirms to responsible offshore development, to include the use of BMPs, in accordance with 30 CFR 585.621" (BOEM 2020b). "Lessees and grantees should conduct all necessary studies of potential interference of proposed wind turbine generators with commercial air traffic control radar systems, national defense radar systems, and weather radar systems; they also should identify possible solutions" (BOEM 2020b).

limited to: the NMFS spring and fall multi-species bottom trawl surveys; the NMFS surf clam survey; the NMFS ocean quahog survey; the NMFS integrated benthic survey/Atlantic scallop survey (optical and dredge); NMFS winter, spring, summer and fall ecosystem monitoring surveys; the NMFS North Atlantic right whale photographic sightings surveys (aerial); the NMFS marine mammal, sea turtle, and seabird vessel surveys; the NMFS marine mammal and sea turtle aerial surveys; the Virginia Institute of Marine Science scallop dredge survey; and the Northeast Area Monitoring and Assessment Program surveys.

Although the Northeast Area Monitoring and Assessment Program survey is within the geographic study area for assessment of impacts in the context of reasonably foreseeable environmental trends, there are no ongoing and planned actions (DEIS Section C.1.13) that are likely to impact this survey since it does not overlap with the proposed Project or reasonably foreseeable offshore renewable energy projects. In the case of the NMFS surveys, BOEM acknowledges that NOAA's Office of Marine and Aviation Operations endorses the restriction of large vessel operations to greater than 1 nautical mile from wind installations due to safety and operational challenges. NOAA evaluated the effects and impacts on these survey operations based on likely foreseeable actions that include the WDA, and all other existing projects within the geographic analysis area, and the analysis is provided in Section 3.12.2.5.

3.12.1.2. Conclusions for the No Action Alternative

Under the No Action Alternative, military and national security uses, aviation and air traffic, cabled and pipelines, radar systems, and scientific research and surveys would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built as proposed under the No Action Alternative, BOEM expects ongoing activities, future non-offshore wind development, and future offshore wind activities to have continuing impacts on military and national security uses, aviation and air traffic, offshore cables and pipelines, radar systems, and scientific research and surveys primarily through presence of structures that introduce navigational complexities and vessel traffic (Table 3.12-1).

BOEM anticipates that the impacts of ongoing activities on other uses would be **negligible** for military and national security uses, aviation and air traffic, cables and pipelines, and radar systems. Trends indicate that ongoing activities in the geographic study area are largely limited to onshore development of FAA-regulated structures, commercial, residential, and industrial developments onshore and along the shoreline, and operation of onshore WTGs. Existing structures exceeding 200 feet AMSL, within FAA jurisdiction (which includes the five Block Island WTGs), or otherwise triggered FAA review would have been reviewed by the FAA with the Department of Defense and Department of Homeland Security invited to provide input, and BOEM assumes any issues with aviation routes or radar systems would have been addressed. Currently, offshore structures in the geographic analysis area for these resources are limited to five Block Island Wind Farm existing offshore cables, met buoys, and navigation aids. The Block Island WTGs also act as FADs, drawing recreational fishing activity. Military and national security use, aviation and air traffic, vessel traffic, and commercial fishing are expected to continue in the geographic analysis area. Impacts of ongoing activities on scientific research and surveys is anticipated to be **moderate** for scientific research and surveys due to the impacts of ongoing offshore wind activities (Block Island Wind) and fishing (static gear) (Weinberg 2020).

In addition to ongoing activities, BOEM anticipates that the impacts of planned actions other than offshore wind would also contribute to impacts on other uses. Planned activities expected to occur in the geographic study area other than offshore wind include increasing vessel traffic, continued residential, commercial, and industrial development onshore and along the shoreline, and continued development of FAA-regulated structures such as communication towers and onshore WTGs. No planned non-offshore wind stationary structures were identified within the offshore portion of the geographic analysis area, and there would be no planned structures to act as navigation hazards or FADs. No planned offshore wind cable activities were identified for the offshore portion of the geographic study area. Any structures exceeding 200 feet AMSL within FAA jurisdiction or otherwise triggering FAA review would be required to submit Form 7460-1 for FAA review, with the Department of Defense and Department of Homeland Security invited to provide input, and BOEM assumes any issues with aviation routes or radar systems would be resolved through this process. Therefore, BOEM anticipates that the impacts of planned actions other than offshore wind to be **negligible** for military and national security uses, aviation and air traffic, cables and pipelines, and radar systems. Impacts of planned actions other than offshore wind on scientific research and surveys are anticipated to be **minor** for scientific research and surveys due to the lack of proposed development in the offshore area. BOEM expects the combination of ongoing activities and planned activities other than offshore wind to result in **negligible** impacts on military and national security uses, aviation and air traffic, cables and pipelines, and radar systems, and **moderate** for scientific research and surveys, primarily driven by potential impacts on finfish, invertebrates, and EFH from climate change and fishing.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with future offshore wind activities in the geographic analysis area combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in **negligible** to **minor** adverse impacts for aviation and air traffic and cables and pipelines; **moderate** adverse impacts to radar systems; **minor** adverse impacts for military and national security uses except for USCG SAR activities, which would be **major**; and **major** adverse impacts for scientific research and surveys, based on the following:

- Impacts on military and national security uses and aviation and air traffic would primarily be caused by installation of up to 775 WTGs in the RI and MA Lease Areas, which would introduce long-term navigational complexity in the region and pose navigational hazards, increasing allision risks for vessels and collision risks for aircraft. Allision risk would be mitigated by navigational hazard marking consistent with BOEM and USCG requirements and guidelines, and by implementing a proposed collaborative regional layout that arranges WTGs in 1 x 1 nautical mile apart in fixed east-to-west rows and north-to-south columns across the entire RI and MA Lease Areas, and by implementing protocols that would cease WTG operations during SAR activities. Potential risks to military and civilian aviation would be mitigated by the existing FAA review process for structures that exceed 200 feet (61 meters) tall within territorial waters, conduct of aeronautical studies by project operators, coordination with military and national security agencies, and implementation of navigational marking of structures according to FAA, USCG, and BOEM requirements and guidelines. Installation of WTGs may necessitate navigational route changes at nearby airports.
- No new cables or pipelines except for offshore wind cables are anticipated to be installed within the geographic analysis area for cables and pipelines. Installation of WTGs and cabling systems within the RI and MA Lease Areas, as well as OECCs, would require future cables to route around offshore wind facilities, and increase risks to vessels conducting maintenance on existing submarine cables located in OCS-A 0487. While future offshore wind cables would need to consider the location of existing cables in routing efforts, cable crossings can be accomplished using standard protection techniques.
- The presence of multiple WTGs throughout the RI and MA Lease Areas would potentially affect weather, military, aeronautical, and research radar systems. Identification and mitigation of potential issues with ground-based radar systems is expected to occur through the FAA review process, coordination with military and national security agencies, and independent studies conducted by project proponents.
- The presence of stationary structures would prevent or hamper continued NMFS scientific research surveys using current vessel capacities and monitoring protocols, and may reduce opportunities for other NMFS 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 proposed WTG height would affect aerial survey design and protocols. BOEM acknowledges that NOAA's Office of Marine and Aviation Operations endorses the restriction of large vessel operations to greater than 1 nautical mile from wind installations due to safety and operational challenges.

The No Action Alternative would forgo the fisheries monitoring that Vineyard Wind has committed to voluntarily perform. Therefore, the results of this monitoring would not be available to provide an understanding of the effects of offshore wind development; benefit future management of finfish, invertebrates, and EFH; or inform planning of other offshore developments. However, other ongoing and future surveys could still provide similar data to support similar goals.

3.12.2. Consequences of Alternative A

The following proposed-Project design parameters (Appendix G) would influence the magnitude of the impacts on other uses:

- Route and timing of the OECC construction, which could affect military vessel activity (surface or submarine) during typical operations and/or training exercises;
- Design, height, number, and arrangement of WTGs and ESPs, which could affect radar systems, movement of civilian and military aircraft, and military vessels (surface or submarine);
- Construction port locations and construction vessel routes, as they relate to the movement of civilian and military aircraft and military vessel activity (surface or submarine) during typical operations and/or training exercises; and
- Configuration of FAA-required aviation obstruction lighting on the WTGs, which would affect civilian and military aircraft navigation.

The analysis contained in this section for military and national security uses, aviation and air traffic, cables and pipelines, and radar systems, and scientific research and surveys is based on a maximum-case impact scenario of 57, 14 MW WTGs, as described in the Vineyard Wind COP. The maximum height of the blade tips of 14 MW turbines proposed in the Vineyard Wind COP exceed the heights described in the DEIS by 147 feet (44.8 meters). If Vineyard Wind were to install 57, 14 MW WTGs instead of the potential 100, 8 MW WTGs initially evaluated, the reduced number of structures and vessel traffic associated with construction and operation would affect other uses as follows:

- Impacts on military and national security uses would increase overall. Although 43 fewer WTGs would be constructed, decreasing the number of WTGs within the WDA, and decreasing vessel traffic associated with construction, operations, and decommissioning, impacts on military and national security uses related to military air traffic would increase because maximum height of WTG blade tips would increase by approximately 147 feet (44.8 meters), WTGs would require additional mid-tower navigation hazard marking, and the proposed Project could require additional changes to air traffic patterns. These differences would not materially change impact ratings for military vessel or air traffic.
- Impacts on aviation and air traffic would increase. Although 43 fewer WTGs would be constructed and the size of the developed area within the WDA would remain the same. However, the maximum height of the WTG blade tips would increase by approximately 147 feet (44.8 meters), WTGs would require additional mid-tower navigation hazard marking, and the proposed Project could require additional changes to air traffic patterns. These differences would not materially change impacts ratings for military air traffic.
- Impacts on future cables and pipelines would remain the same. Although 43 fewer WTGs would be constructed, the size of the developed area within the WDA, and therefore the size of the area that would need to be avoided for future cables and pipelines, would remain the same.
- Impacts on radar systems would slightly increase. Although there would be 43 fewer WTGs, the development area would remain the same and WTGs would be taller, creating a potentially larger radar signature.
- Impacts on scientific research and surveys would remain the same. Although there would be fewer WTGs, the development area would remain the same and survey strata and operations would be similarly impacted.

In general, reducing the number of WTGs to 57 and installing taller 14 MW turbines would change impacts on other uses slightly, primarily due to reduction of number of WTGs, but would not materially change impact findings identified in the DEIS. Increasing the size of the proposed substation by 2.2 acres (less than 0.1 km^2), as described in Chapter 2, would not change the analysis of impacts on other uses for the Proposed Action and all other action alternatives included in the DEIS, due to the small acreage affected.

The impacts of the Alterative A alone and in the context of reasonably foreseeable environmental trends and planned actions are listed by IPF in Table 3.12-1. The most impactful IPFs are presence of structures and increased vessel traffic.

3.12.2.1. Military and National Security Uses

Presence of structures: Existing risks of allisions in the open waters of the geographic analysis area are low due to lack of stationary structures. Alternative A alone would add up to 59 stationary structures (up to 57 WTGs and 2 ESPs) to the WDA during construction and operations, and would also utilize stationary lift vessels in the WDAs and cranes in ports during construction. WTG blade tips would have a maximum height of up 837 feet (255 meters) AMSL. Navigational complexity in the area within and around the WDA would increase as structures are installed during construction or along transit routes, and decrease during project decommissioning. Impacts from other offshore wind projects would be similar but located in the individual project lease areas as described in Appendix A. The Department of Defense concluded that the Proposed Action would have **minor** but acceptable impacts on their operations in 2018 (Fred Engel, Pers. Comm., September 13, 2018), and the Military Aviation and Installation Assurance siting Clearinghouse reviewed the updated COP in 2020 (Military Aviation and Installation Assurance Siting Clearinghouse 2020). These reviews did not include USCG's activities such as SAR. Potential impacts include:

Increased risk of military or national security vessel allisions with stationary structures: The addition of up to 57 WTGs and up to 2 ESPs would increase risk of allisions for military vessels for 30 years during project operations, particularly in bad weather or low visibility. Use of stationary lift vessels within the WDA during construction would also increase allision risk. Military traffic within the WDA is relatively low (four vessels recorded in 2016 and 2017), and deep-draft military vessels are not anticipated to navigate outside of navigation channels unless necessary for SAR operations. Generally, the vessels more likely to allide with WTGs or ESPs would be smaller and moving within and near wind installations. Deep draft military and national security vessels near traffic separations schemes or port entrances could potentially lose power and allide with a nearby WTG. Allision risks could be mitigated by WTG spacing at 1 x 1 nautical mile apart. Vineyard Wind would coordinate with military and national security interests to minimize impacts during construction, operations, and decommissioning. Allision risk would be eliminated after decommissioning when structures are removed. Overall, presence of the Proposed Action's stationary structures would cause localized, long-term, **minor** to **moderate** impacts from allision risk.

Stationary structures associated with ongoing activities and future non-offshore wind activities that increase allision risks are widely dispersed in the open ocean within the geographic analysis area and limited to the five offshore wind turbines associated with the Block Island Wind Farm, deployed meteorological buoys associated with the offshore wind site assessment activities, and shoreline developments such as docks. Impacts from future offshore wind activities would be similar to those of the Proposed Action but more extensive, with up to 775 WTGs and 20 ESPs constructed within the RI and MA Lease Areas before 2030. In context of reasonably foreseeable environmental trends, combined impacts on military and national security uses from increased allision risk from ongoing and planned actions, including Alternative A, would be localized, long-term, and **minor** to **moderate**.

Increased risk of collisions between military vessels and recreational vessels attracted to stationary structures: Construction of Alternative A would add 57 WTGs and 2 ESPs that could create an artificial reef effect, attracting species of interest to recreational fishing or sightseeing, attracting additional recreational fishing and sightseeing vessels that would be additive to existing vessel traffic in the area. The presence of additional recreational vessels would add to conflict or collision risks for military and national security vessels, and could increase demand for SAR operations. Military traffic within the WDA is relatively low (four vessels recorded in 2016 and 2017), and military vessels are not anticipated to navigate outside of navigation channels unless necessary for SAR operations. Risk would increase during operations when stationary structures are installed, and recreational fishing vessels can access the development area. Overall, presence of stationary structures that attract species of interest to recreational fishing or sightseeing within the WDA would cause localized, long-term, **minor** impacts from collision risk. Existing stationary structures associated with ongoing and future non-offshore wind activities that attract species of interest to recreational fishing or sightseeing include the Block Island Wind Farm and shoreline developments such as docks. Impacts from future offshore wind activities would be similar to those of Alternative A, but more extensive, with up to 775 WTGs and 20 ESPs proposed to be constructed within the RI and MA Lease Areas before 2030. In context of reasonably foreseeable environmental trends, combined impacts on military and national security uses from this IPF from ongoing and planned actions, including Alternative A, would be localized, long-term, and **minor**.

Increased risk to military vessels and aircraft due to increased navigational complexity: Construction of Alternative A would add 57 WTGs with maximum blade tip heights of up to 837 feet (255 meters) AMSL and up to 2 ESPs within the WDA, and would necessitate use of stationary lift vessels within the WDA, cranes in ports during construction, and FAA-regulated structures temporarily in transit routes between port and the WDA, increasing navigational complexity and changing navigational patterns for vessels and aircraft operating in the area around the WDA during construction and operation. Increased navigational complexity would increase the risk of collisions and allisions for military and national security vessels or aircraft within the WDA. Structures would be marked as a navigational hazard per FAA, BOEM, and USCG requirements, and risk would be consistent within the 30-year operational period. The WTGs are anticipated to be visible on radar systems of low -flying military and national security aircraft, and would appear similar to other large-scale sea surface activity on radar systems. Nonetheless, the Proposed Action's structures and layout (i.e., lacking 1 x 1 nautical mile spacing and not aligned in east-west rows and north-south columns) would make it more difficult for SAR aircraft to perform operations in the lease area. The USCG would need to adjust their 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. This could lead to increased loss of life due to maritime incidents. As part of the proposed Project, Vineyard Wind would voluntarily implement a strict operational protocol with the USCG that requires the WTGs to stop rotating within a specified time to mitigate impacts on search and rescue aircraft operating in the WDA (COP Volume III, Section 7.8.2.2.3; Epsilon 2020b). The Project filed FAA Form 7460-1 for WTGs located in territorial waters with a maximum height of 212 meters (696 feet) and received Determinations of No Hazard. Prior to construction, Vineyard Wind would refile Form 7460-1 (Notice of Proposed Construction) with the FAA for all temporary and permanent structures exceeding 200 feet (61 meters) tall within territorial waters, including the WTGs. This filing would trigger another review and updated aeronautical studies to identify and resolve potential airspace conflicts. The FAA would invite military and national security interests to review and comment on each Form 7460-1 filing submitted. Vineyard Wind would ensure that a Marine Coordinator remains on duty for the life of the Proposed Action to liaise with the military and national security interests to reduce potential conflicts. These actions would improve safety but would not remove the navigational hazard associated with installing WTGs in the open ocean. The navigational hazard would be gradually eliminated during decommissioning as structures are removed. Overall, the presence of stationary structures in the grid pattern described for Alternative A would cause localized, long-term, **minor** impacts from increased navigational complexity and associated risks, but **moderate** impacts to USCG SAR activities.

Stationary structures associated with ongoing and future non-offshore wind activities would continue to be added primarily onshore and include communications towers, onshore WTGs, and other developments. Impacts from future offshore wind activities would be similar to those of the Proposed Action, but more extensive, with up to 775 WTGs and 20 ESPs proposed to be constructed within the RI and MA Lease Areas before 2030. All onshore or offshore structures located within U.S. territorial waters that exceed 200 feet (61 meters) in height (such as wind turbines and communication towers) would require submittal of Form 7460-1 to the FAA, and the Department of Defense and Department of Homeland Security would be invited to comment through the FAA review process. For example, the Bay State Wind project, proposed to be located closer to ground-based radar systems than the Proposed Actions, received Determinations of No Hazard for WTGs with heights up to 1,049 feet (320 meters) AMSL within U.S. territorial waters (FAA 2019b). Similar to Vineyard Wind 1 Project, it is assumed that project proponents would conduct aeronautical studies to identify and resolve any aviation-related conflicts as part of a project's due diligence, regardless of their position within or outside U.S. territorial waters boundaries. These actions would improve safety but would not remove the navigational hazard associated with installing WTGs in the open ocean. In context of reasonably foreseeable environmental trends, combined impacts on military and national security uses from this sub-IPF from ongoing and planned actions, including Alternative A, would be regional, long-term, and **minor,** but impacts to USCG SAR activities would be increased to **major** due to the larger area affected by other offshore wind projects compared to the WDA.

Increased risk of space use conflicts: During construction, large vessels with limited maneuverability would deliver WTGs, ESPs, and associated equipment to one or more port facilities and to the WDA. These vessels would operate within restricted navigation channels or be on station during construction and installation activities.

Changing navigational patterns could cause space use conflicts as military and national security vessels, commercial vessels, and recreational vessels and aircraft route around the WDA. Military traffic within the WDA is relatively low (four vessels recorded in 2016 and 2017). BOEM coordinated with the Department of Defense throughout the leasing area identification process, environmental review process for the RI and MA Lease Areas, and the COP development and approval process to minimize conflicts with military and national security concerns (Fred Engel, Pers. Comm., September 13, 2018; Military Aviation and Installation Assurance Siting Clearinghouse 2020). The USAF identified a concern that WTGs within warning area W-105A, which overlies the majority of the WDA, could impact the 104th Fighter Wing's ability to train in W-105A. The USAF indicated they were willing to concur with the Proposed Action if structures can withstand daily sonic overpressures from supersonic operations, and potentially falling debris from chaff and flare, and if the USAF would not be held liable for damage to property or personnel (Military Aviation and Installation Assurance Siting Clearinghouse 2020), BOEM will continue to work with the USAF to identify strategies to de-conflict these concerns through conditions of COP approval. Vineyard Wind would ensure that a Marine Coordinator remains on duty for the life of the Proposed Action to liaise with the military and national security interests to reduce potential conflicts. Risks would be eliminated gradually during decommissioning as stationary structures are removed. Overall, presence of stationary structures within the WDA would cause localized, long-term, **minor** impacts from increased space use conflicts.

Stationary structures associated with ongoing activities and future non-offshore wind activities would continue to be added primarily onshore, and would typically include communications towers, onshore WTGs, and other developments. Collectively, onshore developments could cause additional space use conflicts with onshore military activities. Impacts from future offshore wind activities would be similar to those of the Alternative A, but more extensive, with up to 775 WTGs and 20 ESPs proposed to be constructed within the RI and MA Lease Areas before 2030. As multiple projects are built, changing navigation patterns could concentrate vessels within designated navigation corridors and around the outsides of the RI and MA Lease Areas, potentially causing space use conflicts in these areas and increasing the risk of collisions with between military and national security vessels, commercial vessels, and recreational vessels. Offshore wind development could impact military and national security operations conducted within the warning area W-105A, but impacts are anticipated to be minor due to BOEM' s coordination with the USAF to de-conflict concerns about W-105A, and BOEM's continued coordination with the Department of Defense during development of each individual project's COP. In context of reasonably foreseeable environmental trends, combined impacts on military and national security uses from this sub-IPF from ongoing and planned actions, including Alterative A, would be localized, long-term, and **minor**.

Risks associated with transmission cable infrastructure: Cable construction vessels associated with the Proposed Action could cause military and national security vessels to change route or navigate around temporarily active construction sites above cables. Maintenance of the cables during the 30-year operational period is anticipated to be infrequent. Vineyard Wind would continue coordination with military and national security interests to minimize conflicts in active construction or maintenance areas, and will notify the Navy of any proposed use of DAS as a condition of the COP. Impacts on military and national security uses at any one site along the cable route would be localized, temporary, and **negligible**.

Ongoing activities and future non-offshore wind activities are limited to infrequent maintenance events along existing submarine cables within the geographic analysis area. Impacts from future offshore wind activities would be similar to those of the Proposed Action, but at the locations of the Vineyard Wind 2, Mayflower Wind, South Fork Wind, a development by Equinor Wind, and the Bay State Wind cables, and currently unknown cable routes associated with other lease areas offshore Massachusetts and Rhode Island. Construction of cable routes associated with other offshore wind projects would likely be staggered temporally beginning in 2022 and continuing through 2030 (Appendix A, Table A-6), further minimizing risk to military operations. BOEM assumes all offshore wind project operators would coordinate with the Department of Defense and the Navy on any proposed uses of DAS to address impacts on Navy operations, as required by conditions in the COP (Military Aviation and Installation Assurance Siting Clearinghouse 2020). In the context of reasonably foreseeable environmental trends and planned actions including Alternative A, impacts on military and national security from the presence of cables would be localized, temporary, and **negligible**.

Vessel traffic: Vessel traffic associated with construction and decommissioning of the Proposed Action could cause military and national security vessels to change routes, and could cause congestion and delays in port and within transit routes. Vineyard Wind would coordinate with the Navy and USCG during all phases of the proposed Project to minimize conflicts within the WDA, along transit routes, and within ports. The offshore components of the Proposed Action would be monitored and controlled remotely from the Proposed Action's Operations and Maintenance Facilities. During the operational phase, planned maintenance activities would involve dispatching a crew transport vessel to complete repairs and restore normal operations. These activities would be similar to existing civilian vessel activity in and near the WDA, and Vineyard Wind would comply with coordination requirements. Military traffic within the WDA is relatively low (four vessels recorded in 2016 and 2017); therefore, operational conflicts are not anticipated within the WDA. Impacts on military and national security from Proposed Action-related vessel traffic would be localized, temporary, and **minor** during construction and decommissioning, and **negligible** during operations. In the context of reasonably foreseeable environmental trends and planned actions including Alternative A, impacts are most likely to occur during construction and decommissioning timeframes and would be localized, temporary, and **minor**.

BOEM conducted extensive coordination with the Department of Defense throughout the RI and MA Lease Area identification process and associated environmental review to identify and mitigate potential concerns, and has continued to coordinate with military and national security agencies throughout development of the Vineyard Wind I COP. Overall, the Department of Defense reviewed the Proposed Action in its entirety in 2018 and concluded that it would have **minor** but acceptable impacts on their operations; however, the impacts would be **moderate** for USCG SAR. The Department of Defense did not require any additional project or site-specific stipulations not already captured in Section 3.1 (Hold and Save Harmless), 3.2 (Evacuation or Suspension of Activities), and 3.3 (Electromagnetic Emissions) as identified in Addendum C of the Vineyard Wind lease (Fred Engel, Pers. Comm., September 13, 2018; BOEM 2015a). The Navy has informed Vineyard Wind that the Vineyard Wind 1 Project does not raise concerns for their military operations (COP Volume III, Section 2.2.1.1; Epsilon 2020b). In 2020, the Military Aviation and Installation Assurance Siting Clearinghouse provided additional input to the COP that specified the USAF's concerns with warning area W-105A and requested that BOEM continue to coordinate with USAF to de-conflict these concerns. BOEM would implement the USAF's requested stipulations related to warning area W-105A through conditions of COP approval. As part of the proposed Project, Vineyard Wind would voluntarily employ a Marine Coordinator for the life of the Proposed Action to liaise with the military and national security interests to reduce potential conflicts. Vineyard Wind and the USCG would provide Offshore Wind Mariner Updates and Notice to Mariners that describe Vineyard Wind 1 Project-related activities that may be of interest to military and national security interests, including Navy aircraft and vessels operating within the Vineyard Wind 1 Project region. Collectively, these actions would improve safety but would not remove the navigational hazard associated with installing WTGs in the open ocean of the WDA. Therefore, overall impacts of Alternative A on military and national security uses are anticipated to be **minor**, but impacts on USCG SAR would be **moderate** because of navigational challenges associated with navigating SAR aircraft through the WDA.

In the context of reasonably foreseeable environmental trends and planned actions, impacts resulting from individual IPFs associated with Alternative A would range from **negligible** to **major**. Considering all the IPFs together, BOEM anticipates that the impacts associated with Alternative A in the context of reasonably foreseeable environmental trends and planned actions would result in **minor** impacts on military and national security uses in the geographic analysis area, but **major** impacts for USCG SAR operations. The main drivers for these impact ratings are installation of structures, primarily WTGs, within the RI and MA Lease Areas. The Proposed Action would contribute to the overall impact rating primarily through the installation of WTGs and ESPs within the WDA, and to a lesser extent through the addition of Project-related vessels to current vessel traffic between ports and the WDA. While potential impact to most military and national security uses are anticipated to be **minor**, installation of up to 775 WTGs throughout the RI and MA Lease Areas would hinder USCG SAR operations across a larger area, potentially leading to increased loss of life. BOEM conducted extensive coordination with the Department of Defense throughout the RI and MA Lease Areas identification process and associated environmental review to identify and mitigate potential concerns, and will continue to coordinate with military and national security agencies to de-conflict concerns throughout development of each future offshore wind projects in the RI and MA Lease Areas on a project-by-project basis. Other offshore wind operators would be required to coordinate with military and national security interests during the development of the project COPs and during construction, operations, and decommissioning, to identify and mitigate impacts of offshore wind development. The types of impacts would be similar under the No Action Alternative or under Alternative A, but with structures installed across the RI and MA Lease Areas. In context of reasonably foreseeable environmental trends, overall impacts on military and national security uses from ongoing and planned actions, including Alternative A, would likely qualify as **minor** due to required coordination with military and national security agencies, but **major** to USCG SAR operations because of navigational challenges associated with navigating SAR aircraft through the RI and MA Lease Areas when full WTG build out is complete.

3.12.2.2. Aviation and Air Traffic

Presence of structures: Construction of Alternative A would add 57 WTGs with maximum blade tip heights of up to 837 feet (255 meters) AMSL to the WDA. Addition of these structures would increase navigational complexity and change aircraft navigation patterns in the area around the WDA, increasing collision risks for low-flying aircraft during the Proposed Action's operational timeframe. More than 90 percent of existing air traffic over the WDA occurred at altitudes that would not be impacted by the presence of WTGs. Pilots who choose to fly at lower altitudes over open ocean near the WDA would have to alter routes to avoid potential collisions with WTGs. The WTGs would have navigational markings and lighting pursuant to FAA, USCG, and BOEM requirements and guidelines, and would be visible on the radar systems of low-flying aircrafts, similar to other large-scale sea surface activity.

The proposed 14 MW 837-foot (255-meter) blade tip height could necessitate changes to navigation patterns for airports in the region such as Nantucket Memorial Airport and Martha's Vineyard Airport, as well as for the Boston Consolidated and Providence Terminal Radar Approach Control sectors, and a Boston Air Route Traffic Control Center Minimum Instrument Flight Rule Altitude sector. Such changes would be initiated by the FAA, and could impact approximately the 10 percent of air traffic that flies over the WDA at altitudes that could be affected by the Proposed Action. The remaining 90 percent of the existing air traffic over the WDA occurred at heights above 1,500 feet (457 meters) AMSL (COP Volume III, Section 7.9.2.1.2; Epsilon 2020b), and thus would not be affected. The Project filed FAA Form 7460-1 for WTGs located in territorial waters with a maximum height of 212 meters (696 feet) and received Determinations of No Hazard. Prior to construction, Vineyard Wind would refile Form 7460-1 Notice of Proposed Construction for all individual structures in territorial waters exceeding 200 feet (61 meters) tall, including the 14 MW WTGs, construction cranes, and vessels transiting tall structures between port and the WDA during construction and decommissioning. The filing would trigger another review to identify and resolve aviation risks through updated aeronautical studies, with consideration of existing obstacles in FAA records. As part of the proposed Project, Vineyard Wind would voluntarily employ a Marine Coordinator for the life of the Proposed Action to liaise with aviation interests to reduce potential conflicts. While the WTGs in combination with other existing or proposed tall structures onshore and offshore would increase navigational complexity in the area and potentially necessitate changes to air navigation patterns, the FAA has established methods for marking potential obstructions, mitigating potential impacts, and notifying aviation interests about any changes to airspace management. Implementation of these standard procedures would reduce risks associated with impacts from structures on aviation and air traffic. As appropriate, BOEM would require any conditions that FAA imposes for WTGs beyond their jurisdiction. Navigational hazards and collision risks would be gradually eliminated during decommissioning as structures are removed. Overall impacts on aviation and air traffic from Alternative A would be localized, long-term, and **minor**.

Existing stationary structures including the five Block Island wind turbines and communications towers would contribute to impacts, and future stationary structures not associated with offshore wind activities would continue to be added primarily onshore, including communications towers, onshore WTGs, and other developments. Impacts from future offshore wind activities would be similar to those of Alternative A, but increased with up to 775 WTGs with maximum blade tip heights of up to 853 feet (260 meters) AMSL proposed to be constructed within the RI and MA Lease Areas before 2030. As described above, construction of structures exceeding 200 feet (61 meters) in height (such as wind turbines and communication towers) within U.S. territorial waters triggers FAA reviews, through which necessary changes to navigational patterns are identified and implemented. For example, the Bay State Wind project, proposed to be located in OCS-A 500received Determinations of No Hazard for WTGs with heights up to 1,049 feet (320 meters) AMSL within U.S. territorial waters (FAA 2019b). The WTGs associated with the Bay State Wind project were found to exceed obstruction standards of 14 C.F.R. Part 77 in part due to necessary changes in minimum instrument flight altitudes or minimum obstacle clearance altitudes, however, the aeronautical study determined that these impacts would not have a substantial adverse effect on any existing or proposed arrival, departure, or en route IFR operations or procedures (FAA 2019b). Similar to the Proposed Action, it is assumed that project proponents would conduct aeronautical studies to identify and resolve any aviation-related conflicts as part of a project's due diligence regardless of their position within or outside U.S. territorial waters boundaries. As a result, the effects associated with ongoing and planned actions, including Alternative A, would result in regional, long-term, and **minor** impacts on aviation and air traffic uses from this IPF. Overall impacts are classified as **minor** because air traffic would be able to continue over and around the RI and MA Lease Areas after any required changes to air traffic navigation patterns are made through established processes.

3.12.2.3. Cables and Pipelines

Presence of structures: Onshore construction and installation of the Proposed Action would not impact offshore cables and pipelines due to lack of spatial overlap with these facilities. There are no existing submarine cables or pipelines located within the WDA, and the proposed OECC would not cross any submarine cables. Construction of Alternative A would add 57 WTGs and 2 ESPs within the WDA, but are not likely to pose an allision risk to vessels conducting maintenance activities at existing submarine cables near the WDA. Such vessels could route around or through the WDA, but impacts such as allision would be rare due to infrequency of submarine cable maintenance. Presence of the 57 WTGs and 2 ESPs, and an inter-array cabling system within the WDA, could preclude future submarine cable development through the WDA. Future submarine cables, including future offshore wind export cables, would need to be routed around the WDA during the operational timeframe. Space use conflicts could be eliminated during decommissioning if structures are removed. Any future crossings of the OECC and new submarine cables can be protected by standard techniques during construction, operations, and decommissioning; therefore, overall impacts on cables are anticipated to be localized, long-term, and **negligible**.

Ongoing maintenance of existing submarine cables, including the Block Island Wind Farm OECC and two submarine cables located in the western portion of OCS-A 0487, would continue into the future, and future offshore wind activities would restrict future cable placement within developed areas of the RI and MA Lease Areas. Eight submarine cables and no pipelines were identified within the geographic analysis area. Two cables cross the far western portion of OCS-A 0487 within the area proposed for the Sunrise Wind, which is projected to be operational in 2024. These cables are associated with a larger network of submarine cables that are located south of the lease areas and make landfall near Charlestown, Massachusetts. Cable maintenance vessels transiting through the leased areas, and vessels conducting infrequent maintenance on the two submarine cables that cross OCS A 0487 would be at risk of allisions, but risk would be mitigated by required navigational hazard marking and implementation of a 1 x 1 nautical mile spacing throughout the leased areas. Future cables may be precluded from all developed areas within the RI and MA Lease Areas after installation of WTGs, ESPs, and inter-array cabling systems due to the density of cables within the WDA, but future cables could cross the OECC because cables could be protected by standard techniques. Therefore, in context of reasonably foreseeable environmental trends, the overall impacts from ongoing and planned actions, including Alternative A, are anticipated to be localized, long-term, and **negligible** because impacts can be avoided by standard cable protection techniques.

3.12.2.4. Radar Systems

Presence of structures: Construction and operation of onshore facilities associated with the Proposed Action are not anticipated to impact radar systems. Construction of Alternative A would add up to 57 WTGs with maximum blade tip heights of up to 837 feet (255 meters) AMSL height to the WDA during the construction period. While WTGs in the direct line-of-sight with or extremely close to radar systems can cause clutter and interference, most ground-based radar systems are located a sufficient distance from the WDA that radar interference is not anticipated and mitigation would not be required. For weather radars, a U.S. Department of Energy screening tool for WTG siting did not identify any potential conflicts between the Proposed Action and ground-based NOAA NEXRAD weather radars, (COP Volume III, Section 7.9.2.1.2; Epsilon 2020b). The Proposed Action is outside of the instrumented range for the FAA's Terminal Doppler Weather Radar located at Boston Logan International Airport (COP Volume III, Section 7.9.2.1.2; Epsilon 2020b). Vineyard Wind's prior filings for WTGs with a maximum height of 696 feet received "Determinations of No Hazard" from the FAA, which found that although the WTGs studied would be within the line-of-sight for two regional radar systems (Nantucket ASR-9 and Falmouth ASR-8), “it was determined that this would not have a substantial adverse effect to operations at this time.” The Military Aviation and Installation Assurance Siting Clearinghouse conducted a review of the updated COP in 2020, and determined that the proposed Project would adversely impact NORAD’s air defense mission by causing interference with the Falmouth ASR-8 and Nantucket ASR-9. The Clearinghouse states that the interference would result in “increased false targets, reduced radar sensitivity, decreased probability of detection and radar tracking anomalies in the area over and near the wind project” but Radar Adverse Impact Management (RAM) and overlapping radar coverage together would mitigate impacts to an acceptable level (Military Aviation and Installation Assurance Siting Clearinghouse 2020). To address these concerns, BOEM would include approval conditions in the COP regarding notification to NORAD of RAM scheduling, funding of RAM execution, and curtailment for national security or defense purposes as needed. Any other impacts on radar systems are anticipated to be mitigated by overlapping coverage and radar optimization (COP Volume III, Section 7.9.2.2.6; Epsilon 2020b). The FAA would evaluate potential impacts on radar systems, as well as mitigation measures when Vineyard Wind refiles Form 7460-1 for individual WTGs located within U.S. territorial waters. Vineyard Wind’s Marine Coordinator would remain on duty for the life of the Proposed Action to liaise with military, national security, civilian, and private interests to reduce potential radar conflicts. Impacts on radar systems from Alternative A are anticipated to be localized, long-term, and **minor**. Impacts would be eliminated when the WTGs are decommissioned.

Development of larger areas of the RI and MA Lease Areas 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 within the RI and MA Lease Areas could create a large geographic area of degraded radar coverage that could impact multiple radars. As with the proposed Project, development of other projects in the RI and MA Lease Areas could adversely affect NORAD’s operations and mission (Military Aviation and Installation Assurance Siting Clearinghouse 2020). Impacts on radar systems from existing structures exceeding 200 feet in height within U.S. territorial waters would have been identified through the FAA Form 7460-1 filing process, and any future non-offshore wind and offshore wind structures exceeding 200 feet in height within U.S. territorial waters must follow the same process. This analysis process, along with coordination with military and national security agencies, would identify potential impacts and any mitigation measures specific to radar systems for each WTG filled in accordance with FAA Order JO 7400.2M (FAA 2019a). For example, the Bay State Wind project, proposed to be located in OCS-A 500, closer to some ground-based radar systems than the Proposed Action, received “Determinations of No Hazard” for WTGs with heights of up to 1,049 feet (320 meters) AMSL. Although WTGs associated with the Bay State Wind project were found to be within the direct line-of-sight for the Falmouth ASR-8, Nantucket ASR-9, and Coventry ASR-9 radar systems, the FAA’s aeronautical study determined that the Bay State Wind Project would not have a substantial adverse effect to radar operations at the time of study (FAA 2019b). Similar to Proposed Action, it is assumed that project proponents would conduct aeronautical studies to identify and resolve any aviation-related conflicts as part of a project’s due diligence regardless of their position within or outside U.S. territorial waters boundaries, in compliance with BOEM’s radar-specific recommendations for COP development (BOEM 2020b). In addition, 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 de-conflict concerns related to individual projects or multiple projects with COP approval conditions. BOEM anticipates that potential impacts on aeronautical, military, and weather radar systems from other onshore and offshore wind projects would be identified and mitigated through the FAA 7460-1 review process (if applicable), the Military Aviation and Installation Assurance Siting Clearinghouse review process, and by individual reviews conducted by project proponents. Impacts would gradually increase during the construction period, and decrease as multiple project WTGs are decommissioned; therefore, in context of reasonably foreseeable environmental trends, ongoing and planned actions, including Alternative A, the overall impacts on radar systems would be regional, long-term, and **moderate** with potential conflicts addressed through established processes and COP approval conditions.

3.12.2.5. Scientific Research and Surveys

Construction of Alternative A would add up to 57 WTGs with maximum blade tip heights of up to 837 feet (255 meters) AMSL height to the WDA during the construction period. Construction of the Proposed Action and other foreseeable offshore wind projects would add an estimated 775 WTGs to the RI and MA Lease Areas and

1,059 WTGs outside the New England area, with a maximum height of 853 feet (260 meters) AMSL. These WTGs would be removed during project decommissioning. Research activities may continue within the proposed WDA during construction and installation, as permissible by survey operators and boat captains. The proposed Project would impact survey operations by excluding certain areas within the WDA occupied by project components (e.g., WTG foundations, cable routes) from potential sampling, and by impacting survey gear performance, efficiency, and availability. 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. NOAA's Office of Marine and Aviation Operations has determined that the NOAA Ship Fleet will not operate in wind facilities with 1 nautical mile or less separation between turbine foundations.

The following provides NOAA's evaluation of the potential impacts on these survey operations based on likely foreseeable actions, including the WDA and all other existing federal lease areas from Maine to mid-North Carolina.

Fish and shellfish research programs: Randomized station selection methodologies that are employed by most of the shipboard scientific fish and shellfish surveys would not be able to be applied in wind energy areas. Loss of survey areas would increase the uncertainty in estimates of fish and shellfish stock abundances and of oceanographic parameters. If abundances, distributions, biological rates, or environmental parameters differ inside versus outside wind energy areas but cannot be observed, resulting survey indices could be biased and unsuitable for monitoring stock status. Similarly, resulting regional oceanographic time series could also be biased. A broad analysis for the NMFS bottom trawl surveys that considered current and planned wind areas found that 9 out of 14 offshore strata that contribute most of the area sampled in the Southern New England Mid-Atlantic region would likely be affected. Strata for fish and shellfish surveys are defined based on depth and alongshore features, to delineate areas of relatively homogeneous species distributions. Random sampling within a stratum is a key attribute of statistical performance of these and many other typical survey designs.

The Vineyard Wind lease area alone overlaps strata associated with three different coast-wide Northeast Fisheries Science Center fishery resource monitoring surveys. For the spring and fall multi-species bottom trawl surveys, 6 percent of the area in one stratum would be within the Vineyard Wind lease area. For the ocean quahog survey, 3 percent of the area in one stratum would be within the lease area. As a result, Alternative A would result in major impacts on NOAA's scientific surveys.

The effects of other offshore wind projects would be similar, over an extended area. For the spring and fall multi-species bottom trawl surveys, 16 of the Southern New England—Mid-Atlantic strata would be affected, although overlap is less than 1 percent in 2 strata. Between 3 and 60 percent of each remaining 14 stratum's area would be covered by offshore wind lease areas, including the Proposed Action. The percent of area made unavailable would be higher in inshore strata (mean of 18 percent) than offshore strata (mean of 11 percent). Of the 14 offshore strata that contribute most of the area surveyed in the region, 9 are affected. In the case of Offshore Stratum 9, for example, which includes the Proposed Action and contiguous lease areas, up to 37 percent of the area could be unsampleable. For the integrated benthic/Atlantic sea scallop survey, four routinely sampled strata would likely be affected, with 3 to 12 percent of the stratum areas potentially unsampleable. For another two strata that are intermittently dredge sampled through the Virginia Institute of Marine Science Research Set Aside program, 21 to 56 percent of the area within those two strata would potentially be unsampleable. For the ocean quahog survey, four out of twelve strata would include offshore wind lease areas, with 3 to 19 percent of the stratum areas potentially unsampleable. For the surfclam survey, three out of twelve survey strata would include offshore wind lease areas, with 7 to 14 percent of the stratum areas potentially unsampleable. Low percentage overlaps for these two shellfish surveys may still have substantial effects, because there are only a few large strata in both surveys. Areas occupied by OECCs, which could not be trawled or dredged, are not included in these estimates. In summary, depending on the survey, up to 33 percent of strata within a survey would potentially be affected, and up to 60 percent of a single stratum within a survey would potentially be affected.

As noted above, removing survey effort to remaining areas that can be sampled would not mitigate the effects. Without new alternative sampling methods and statistical designs, relocation of survey efforts would affect sampling accuracy. In addition, impacts could extend to operations outside wind energy areas, decreasing remaining survey precision. Based on layout and spacing of WTGs and current survey vessel operation policies, NMFS-supported vessels would not transit through wind energy lease areas. Alteration of survey vessel routes and resultant increased travel times would reduce survey productivity and precision.

Protected species (cetaceans, sea turtles, and pinnipeds) research programs: Aerial survey track lines at the altitude used in current cetacean and sea turtle abundance surveys (600 feet [183 meters] AMSL) could not occur in offshore wind areas, because the planned maximum-case scenario WTG blade tip height (837 feet [255 meters] AMSL for the Proposed Action and 853 feet [260 meters] AMSL for other projects) would exceed the survey altitude with current surveying methodologies. The increased altitude necessary for safe survey operations could result in lower chances of detecting marine mammals and sea turtles, especially smaller species. At a minimum, NOAA Office of Marine and Aviation Operations pilots maintain a safety zone of at least 500 vertical feet from structures and hazards. The RI and MA Lease Areas comprise less than 1.5 percent of the aerial survey stratum, although the visual aerial abundance surveys for this stratum, contributes to the estimates of 30 or more stocks of cetaceans and sea turtles. Thus, if animal distribution is not affected by offshore wind activities and NMFS surveys do not include these areas, the reduction in survey stratum area would have a minimal effect on abundance estimates for protected species. Impacts would be more substantial if the distribution and/or abundance within the RI and MA Lease Areas was different than the surrounding areas that continue to be surveyed.

Considerable survey efforts have been underway for years using digital aerial surveys for protected species in offshore wind areas. NMFS has begun investigating whether photographic abundance/monitoring surveys flown at a higher altitude are practical, reliable, and result in appropriately accurate and precise distribution and abundance estimates. More work is needed to confirm whether higher-altitude photographic survey methods are appropriate for abundance and monitoring surveys for all cetaceans, pinnipeds, and sea turtles.

A recent study found that the seven contiguous lease areas offshore Massachusetts and Rhode Island encompass important habitat that is utilized by NARWs (Leiter et al. 2017). Over one third of the current population, including up to 30 percent of known calving females, visited the RI and MA Lease Areas between 2010 and 2015. NMFS uses aerial surveys to collect photographs of the NARWs and other species to estimate abundance and monitor the health and status of individuals and populations. Shipboard surveys and small boat work also collect detailed data on NARWs, including photographs and drone images, biopsy samples, fecal samples, acoustic recordings, and other data types. Prey sampling in the vicinity of NARWs and in areas where they are not aggregating is being used to better characterize the habitat drivers behind their distribution. Finally, passive acoustic technology is used to monitor the presence of vocally active NARWs and other endangered large whale species throughout sites along the U.S. East Coast.

Development of offshore wind in the RI and MA Lease Areas would impact approximately 60 percent of the NARW aerial survey blocks in the area. NARW aerial surveys are currently conducted at 1,000 feet AMSL, but would need to be conducted at higher altitudes to provide safety margins, as discussed above. The inability to continue flights at current altitudes (600 or 1,000 feet AMSL) over offshore wind areas would have a significant effect on the ability to use current data collection techniques to monitor the distribution and abundance of marine mammals and sea turtles that may be caused by or are related to offshore wind. Alternative techniques to monitor these species could include high altitude photographic surveys, passive acoustic monitoring, and data collection on small vessels (including those used by the industry) that can safely navigate within the wind turbines.

The inability to implement shipboard surveys in current NARW habitat in offshore wind areas could significantly affect NMFS' ability to monitor the health, status, and behavior of individuals within this region, as well as NMFS' ability to monitor changes in prey distribution and other factors affecting NARW habitat use. With the operational restrictions on NOAA vessels entering developed lease areas, surveys within WDAs would necessarily require wind development-compatible vessels and equipment, which could lead to changes in survey methodology, available tools, and appropriate staffing of shipboard fieldwork. This would lead to less effective and efficient on-water data collection. Finally, the impact on collecting passive acoustic data in the region once offshore wind projects are developed is unknown. The use of autonomous vehicles, such as gliders, has been an important component in NMFS' near-real-time monitoring of NARW distribution, and the use of archival recorders has been important for documenting habitat use over time. It is unclear how this would change after the installation of WTGs, whether these data collection methodologies would still be feasible in these areas, and how noise from operations (i.e., construction or vessel noise from long-term turbine maintenance) would affect NMFS' ability to continue to acoustically detect animals reliably. In summary, additional work is needed to develop and implement appropriate strategies to collect, analyze, interpret, and share data to monitor the effects of wind energy activities on all protected species.

Summary: Significant resources would be required to quantify and account for the complexity and scope of effects on NMFS core scientific surveys and the management advice that relies on these surveys, and to implement necessary survey adaptations. Potential challenges would include identification of appropriate sampling protocols and technology, development and parameterization of new statistical survey models, and calibration of new approaches to existing ones in order to continue to sample within areas occupied by turbine foundations and submarine cables. Preliminary analyses of the effects on survey areal coverage shows substantial impacts on NMFS' ability to continue using current methods to fulfill its mission of precisely and accurately assessing fish and shellfish stocks for the purpose of fisheries management, and assessing protected species for the purpose of protected species management. Changes to protected species survey methodologies could introduce biases or inaccuracies that could impact marine mammal abundance estimates and dedicated NARW studies. These changes could result in management implications for NARW and other protected species, as well as for fisheries and shipping industries that impact these species. Similarly, changes to existing survey methodologies or disruption to the long-term survey time series of fish and shellfish would have implications for stock assessments by increasing uncertainty in biomass estimates and other parameters used in projecting fishery quotas. Uncertainty in estimating fishery quotas could lead to unintentional underharvest or overharvest of individual fish stocks, which could have both beneficial and adverse impacts on fish stocks, respectively. Based on existing regional Fishery Management Councils' acceptable biological catch control rule processes and risk policies (e.g., 50 C.F.R. §§ 648.20 and 21), increased assessment uncertainty would likely result in lower commercial quotas that may reduce the likelihood of overharvesting and mitigate associated biological impacts on fish stocks. However, such lower quotas would result in lower associated fishing revenue that would vary by species, which could result in impacts on fishing communities. Development of new survey technologies, changes in survey methodologies, and required calibrations could help to mitigate losses in accuracy and precision of current practices due to the impacts of wind development on survey strata. Until a plan is established to holistically mitigate impacts on NMFS core surveys, information generated from project-specific monitoring plans may be necessary to supplement or complement existing survey data. Such monitoring plans must be developed in a comprehensive and integrated manner consistent with NOAA and NMFS' long-standing surveys. To address this need, these fisheries monitoring plans should be developed collaboratively with NOAA and NMFS and incorporate NMFS survey standards and requirements to ensure collected data is usable. BOEM will continue to work with the NMFS in regards to survey guidelines and update guidelines as appropriate to reflect standard data collection protocols and methodologies.

Federal Survey Mitigation Program: To address the proposed Project's impacts on NMFS trust responsibilities under MSA, ESA, and MMPA, NMFS, in partnership with BOEM, is considering a mitigation program to establish resources for the NMFS Northeast Fisheries Science Center to design and implement effective survey adaptations. The intent of this mitigation program would be to minimize or avoid adverse consequences from the proposed Project. If successful, this mitigation program could potentially be applied to future offshore wind projects. Specifically, NMFS recommends implementation of a mitigation program that includes the specific elements listed below to address the proposed Project's adverse impacts on the multi-species bottom trawl surveys, Atlantic scallop surveys, ocean quahog and Atlantic surf clam surveys, ecosystem monitoring surveys, marine mammal and sea turtle ship-based and aerial surveys, and NARW aerial surveys. While this mitigation is focused on the proposed Project, impacts from future offshore wind projects on NOAA scientific surveys would be mitigated through future coordination between BOEM and NOAA, as well as measures included in future NEPA analyses. These analyses would include consideration of the following mitigation measures as they apply to impacts from future projects.

- Evaluate survey designs—Evaluate and quantify the proposed Project's effects on the listed scientific survey operations and on provision of scientific advice to management.
- Identify and develop new survey approaches—Evaluate or develop appropriate statistical designs, sampling protocols, and methods, while determining if scientific data quality standards for the provision of management advice are maintained.
- Calibrate new survey approaches—Design and carry out necessary calibrations and required monitoring standardization to ensure continuity, interoperability, precision, and accuracy of data collections.

- Develop interim provisional survey indices—Develop interim ad hoc indices from existing non-standard data sets to partially bridge the gap in data quality and availability between pre-construction and operational periods while new approaches are being identified, tested, or calibrated.
- Wind energy monitoring to fill regional scientific survey data needs—Apply new statistical designs and carry out sampling methods to mitigate the proposed Project's survey impacts over the operational life span of the Project.
- Develop and communicate new regional data streams—New data streams would require new data collection, analysis, management, dissemination, and reporting systems. Changes to surveys and new approaches would require substantial collaboration with fishery management, fishing industry, scientific institutions, and other partners.

The research and surveys listed above are a subset of all scientific research and surveys that may be executed in the geographic analysis area. Other scientific research surveys utilizing fixed data recorders, automated underwater vehicles, and small vessel research platforms may not be similarly impacted. There are currently no federal requirements to monitor or research construction and operation of offshore wind projects, or for advancing new survey technologies. BOEM will continue to work with survey operators to better define and understand these impacts, including whether effective mitigation options could be available to compensate for the potential loss of some scientific surveys. Construction and decommissioning of Alternative A could lead to increased opportunities to study impacts of construction and operation of the offshore components, perform other oceanographic research, and develop or adapt new approaches to research including but not limited to use of unmanned aerial vehicles or vessels, and remote sensing and digital technologies. Operations and maintenance activities may present an opportunity to collaborate with researchers on data collection, thus potentially reducing survey costs. NOAA's Unmanned Systems Strategy (NOAA 2020g), which aligns with the Commercial Engagement Through Technology Act of 2018 (Public Law 115-394), is intended to "directly improve the understanding, coordination, awareness and application of [unmanned systems]. In addition, sampling, monitoring, and/or research contributions from the offshore wind industry and other non-NOAA stakeholders (e.g., other federal or military agencies, industry partners, and academia) could play a key role in development of innovative approaches that would enable to scientific research and surveys to continue in offshore wind development areas. These approaches and opportunities help inform certain types of scientific research and surveys in the long-term, but Alternative A would still have **major** effects on existing NMFS scientific research and surveys conducted in and around the WDA because long-standing surveys would not be able to continue as currently designed, and extensive costs and efforts will be required to adjust survey approaches, potentially leading to impacts on fishery participants and communities (Sections 3.6.2 and 3.10.2); as well as potential **major** impacts on monitoring and assessment activities associated with recovery and conservation programs for protected species. The loss of precision and accuracy would be a significant hurdle, as new data collection methods are tested and become usable and robust over time. Implementing mitigation measures, including the development of survey adaptation plans, standardization and calibration of sampling methods, and annual data collections following new designs and methods would help reduce uncertainty in survey data and associated assessment results and increase the utility of additional data collected as part of any required project-specific monitoring plan.

In context of reasonably foreseeable environmental trends, BOEM anticipates that the impacts associated with ongoing and planned actions, including Alternative A, would have **major** impacts on NMFS' scientific research and surveys and the resulting stock assessments, which could lead to potential beneficial and adverse impacts on fish stocks when management decisions are based on biased or imprecise estimates of stock status. Alternative A would contribute to the overall impact rating primarily through placement of structures in the long-term within the WDA that pose navigational hazards to survey aircraft and vessels and restrict access to survey locations, thus impacting statistical design of surveys and causing a loss of information within the wind development areas as previously described. Impacts of Alternative A are similar to those of other reasonably foreseeable offshore wind development, but effects would be spread across the RI and MA Lease Areas, affecting additional survey strata and survey areas. In context of reasonably foreseeable environmental trends, ongoing and planned actions, including Alternative A, the overall impacts on 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, the commercial fisheries community, protected species research, and programs for the conservation and management/recovery of fishery resources and protected species. While new research approaches and technologies may lessen impacts on scientific research and surveys in the long-term, their results and applicability specific to the impacted NOAA and NMFS surveys are not reasonably foreseeable at this time.

3.12.2.6. Conclusions for Alternative A

In summary, activities associated with the construction and installation, operations and maintenance, and decommissioning of the Proposed Project would impact other uses to varying degrees. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.12.1.2. Based on the analysis above, Alternative A would have the following impacts on other uses.

Military and National Security Uses: Potential impacts on military and national security uses would primarily be caused by installation of WTGs in the offshore portion of the geographic analysis area. The Proposed Action's stationary structures would cause localized, long-term, **minor** to **moderate** impacts from allision risk; localized, long-term, **minor** impacts from allision risks and elevated need for SAR operations due to increased interest to recreational fishing or sightseeing within the WDA; localized, long-term, **minor** impacts to most military and national security uses from increased navigational complexity and associated risks, but **moderate** impacts to SAR operations; localized, long-term, **minor** impacts on military vessels and aircraft from increased space use conflicts; and **negligible** impacts from potential conflict with vessels conducting export cable construction and maintenance. Impacts on military and national security from Proposed Action-related vessel traffic would be localized, temporary, and **minor** during construction and decommissioning, and **negligible** during operations. As part of the proposed Project, Vineyard Wind would voluntarily implement a strict operational protocol with the USCG that requires the WTGs to stop rotating within a specified time to mitigate impacts on search and rescue aircraft operating in the WDA (COP Volume III, Section 7.8.2.2.3; Epsilon 2020b). Vineyard Wind's employment of a Marine Coordinator to liaise with military and national security interests as needed. These actions would improve safety but would not remove the navigational hazard associated with installing WTGs in the open ocean. BOEM would continue to work with military and national security agencies to identify and de-conflict the USAF's concern about warning area 105A.Therefore, overall impacts of Alternative A on military and national security uses are anticipated to be **minor**, but impacts on USCG SAR would be **moderate** because of navigational challenges associated with navigating SAR aircraft through the WDA.

Aviation and Air Traffic: Potential impacts on aviation and air traffic would primarily be caused by installation of WTGs in the offshore portion of the geographic analysis area, but construction cranes and WTGs under construction may also trigger the need for FAA clearance in the WDA, in ports, and along transit routes between ports and the WDA. Overall impacts on aviation and air traffic from Alternative A would be localized, long-term, and **minor**. Some changes to navigational patterns associated with local airports may be necessary as identified through FAA filings and aeronautical studies, and Vineyard Wind would employ a Marine Coordinator for the life of the Proposed Action to liaise with aviation interests to reduce potential conflicts.

Cables and Pipelines: Potential impacts on aviation and air traffic would be **negligible** due to the lack of existing submarine cables and pipelines in the WDA and crossing OECC routes. Although future submarine cables, including future offshore wind export cables, would need to be routed around the WDA, the OECC cables could be crossed using standard techniques to avoid impacts.

Radar Systems: Potential impacts on radar systems would be localized, long-term, and **minor**. Although presence of WTGs has the potential to cause interference with radar systems, ground-based radar systems are located a sufficient distance from the WDA that radar interference is not anticipated and mitigation would not be required. The FAA would evaluate potential impacts on radar systems, as well as mitigation measures when Vineyard Wind refiles Form 7460-1 for individual WTGs located within U.S. territorial waters. Vineyard Wind's Marine Coordinator would remain on duty for the life of the Proposed Action to liaise with military, national security, civilian, and private interests to reduce potential radar conflicts. BOEM would continue to work with military and national security agencies to identify and de-conflict concerns about radar impacts.

Scientific Research and Surveys: Potential impacts on scientific research and surveys would generally be **major**, particularly pertaining to NOAA and NMFS surveys supporting commercial fisheries and protected species research programs. Presence of structures would exclude certain areas within the WDA occupied by project components (e.g., WTG foundations, cable routes) from potential vessel and aerial sampling, and by impacting survey gear performance, efficiency, and availability.

In context of other reasonably foreseeable environmental trends in the area, impacts of individual IPFs resulting from ongoing and planned actions, including Alternative A, would range from **negligible** to **major** and would be similar to those associated with Alternative A, but variable in location and timeframe. Considering all the IPFs together, BOEM anticipates that the impacts from ongoing and planned actions, including Alternative A, would result in the following impacts.

Military and National Security Uses: Potential impacts on military and national security uses would primarily be caused by installation of WTGs across the RI and MA Lease Areas. Presence of stationary structures (mostly WTGs) would cause localized, long-term, and **minor to moderate** impacts from allision risk; localized, long-term, **minor** impacts from allision risks and elevated need for SAR operations due to increased interest to recreational fishing or sightseeing within the lease areas; localized, long-term, **minor** impacts from increased navigational complexity across the RI and MA Lease Areas and associated risks, but **major** impacts to SAR operations; localized, long-term, **minor** impacts on military vessels and aircraft from increased space use conflicts; and **negligible** impacts from potential conflict with vessels conducting export cable construction and maintenance. Impacts on military and national security from Proposed Action-related vessel traffic would be localized, temporary, and **minor** during construction and decommissioning, and **negligible** during operations. Considering all the IPFs together, BOEM anticipates that the impacts associated with Alternative A in the context of reasonably foreseeable environmental trends and planned actions would result in **minor** impacts on most military and national security uses in the geographic analysis area, but **major** impacts on USCG SAR operations. The main drivers for these impact rating are installation of structures, primarily WTGs, within the RI and MA Lease Areas that would hinder USCG SAR operations, leading to increased loss of life. FAA review, coordination with military and national security interests, and other mitigation actions may improve safety of SAR operations, but these measures would not remove the navigational hazard associated with installing WTGs over a larger area in the open ocean.

Aviation and Air Traffic: Potential impacts on aviation and air traffic would primarily be caused by installation of WTGs throughout the leased areas, but construction cranes and WTGs under construction may also trigger the need for FAA clearance in the leased areas, in ports, and along transit routes between ports and the leased areas. Construction of structures exceeding 200 feet (61 meters) in height (such as wind turbines and communication towers) within U.S. territorial waters triggers FAA reviews, through which necessary changes to navigational patterns are identified and implemented. It is assumed that project proponents would conduct aeronautical studies to identify and resolve any aviation-related conflicts as part of a project's due diligence regardless of their position within or outside U.S. territorial waters boundaries. Overall impacts are classified as regional, long-term, and **minor** because air traffic would be able to continue over and around the RI and MA Lease Areas after any required changes to air traffic navigation patterns are made through established processes.

Cables and Pipelines: Cable maintenance vessels transiting through the leased areas, and vessels conducting infrequent maintenance on two submarine cables would be at risk of allisions, but risk would be mitigated by navigational hazard marking and implementation of a 1 x 1 nautical mile spacing throughout the leased areas. Future cables may be precluded from all developed areas within the RI and MA Lease Areas after installation of WTGs, ESPs, and inter-array cabling systems due to the density of cables within the WDA, but future cables could cross the OECC because cables could be protected by standard techniques. In the context of reasonably foreseeable environmental trends and planned actions including Alternative A, the overall impacts are anticipated to be localized, long-term, and **negligible**.

Radar Systems: BOEM anticipates that potential impacts on radar systems from other onshore and offshore wind projects would be identified and mitigated through the FAA 7460-1 review process, individual reviews conducted by project proponents, and BOEM's coordination with military and national security agencies to identify and de-conflict impacts on radar systems. Impacts would gradually increase during the construction period, and decrease as multiple project WTGs are decommissioned; therefore, in the context of reasonably foreseeable environmental trends and planned actions including Alternative A, the overall impacts on radar systems would be regional, long-term, and **moderate** and potential conflicts addressed through established processes.

Scientific Research and Surveys: In the context of reasonably foreseeable environmental trends and planned actions including Alternative A, overall impacts on NOAA and NMFS 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, and the commercial fisheries community. There could be impacts on other types of surveys, and increased opportunities to study impacts of offshore wind development on a variety of resources.

While the significance level of impacts would remain the same, the following mitigation measures could further reduce impacts (Appendix D):

- Cable burial monitoring
- Dynamic Squid Fishing Avoidance Plan
- Use of AIS on all Project Vessels
- Time-of-year restrictions
- Post installation cable monitoring
- Compensation funds for fisheries interests from Rhode Island, Massachusetts, and other states
- Contributions to the Rhode Island Fisherman's Future Viability Trust
- Trawl survey for finfish and squid
- Ventless trap surveys
- Conditions of COP Approval to as suggested by military and national security agencies, to de-conflict USAF concerns about warning area W-105A and to address potential impacts to Nantucket ASR-9 and Falmouth ASR-8 radar systems

3.12.3. Consequences of Alternatives C, D1, and E

Alternative C would exclude six of the northernmost WTG locations and relocate them in the southern portion of the lease area primarily for the purpose of reducing visual impacts and minimizing conflicts with commercial fishing vessels. Alternative D1 increases the spacing between WTGs in the WDA to 1 nautical mile to reduce potential conflicts with ocean uses. Alternative E would allow no more than 84 WTGs.

All other design parameters and potential variability in design would be the same as under Alternative A. This assessment analyzes the maximum-case scenario; any potential variances in the proposed-Project build-out as defined in the PDE (i.e., numbers and spacing of WTGs and ESPs, length of inter-array cable) or construction activities would result in similar or lower impacts than described below. For example, if Vineyard Wind were to use fewer, larger WTGs and less total length of cable, impacts resulting from the installation and operation of these elements would be less than the maximum described in this analysis.

- Impacts of Alternative C alone would be similar to Alternative A for cables and pipelines, radar systems, and scientific research and surveys. Implementation of Alternative C could slightly increase impacts on military and national security vessel traffic and air traffic by moving additional turbines into military warning area W-105A. Alternative C could potentially decrease impacts on air traffic and aviation by moving WTGs farther away from regional airports and associated obstacle clearance surfaces, and placing WTGs where obstacle clearance surfaces are higher in elevation (COP Volume III, Appendix III-J; Epsilon 2020b). Under Alternative C, three fewer turbines would be located in U.S. territorial waters, and only five turbines would be subject to FAA jurisdiction, compared to eight in Alternative A (COP Volume III, Appendix III-J; Epsilon 2020b). All structures would be still be subject to navigational hazard marking per FAA, BOEM, and USCG requirements and guidelines. Moving the WTGs farther to the south would still require similar measures to accommodate the proposed Project—including coordination with military and national security entities, and changes to air traffic navigational patterns—and the overall level of impact would not change.
- Alternative D1 would increase the size of the WDA and require different navigation routes for vessels within the WDA, and would implement a 1 x 1 nautical mile spacing between each WTG, but would not alter Alternative A's northeast-southwest/northwest-southeast grid orientation. While risks associated with vessel allisions, vessel-related navigation hazards, and space use conflicts on the water may be reduced, measures to accommodate the proposed Project and the overall level of impact would not change.

- The difference between Alternative E and Alternative A is the installation of between 57 and 84 WTGs of varying individual capacities, with a total Proposed Action capacity of 800 MW. If a larger number of smaller-capacity WTGs are selected (i.e., 84, 9 to 10 MW WTGs), the number of installed structures within the WDA would increase but turbines would be shorter in height. The impacts of construction, operations, maintenance, and decommissioning of Alternative E on other uses would be the same for cables and pipelines, but incrementally somewhat smaller than the revised Proposed Action for military operations and national security, aviation and air traffic, radar systems, and scientific research and surveys due to use of shorter WTGs. However, construction of a larger number of smaller-capacity turbines would still require similar measures to accommodate the proposed Project including coordination with military and national security entities and changes to air traffic navigational patterns. The magnitude of impacts would not change.

Implementation of Alternatives C, D1, and E would not result in meaningfully different types or magnitudes of impacts on other uses compared to Alternative A. Therefore, the overall reported level of impact would remain similar to Alternative A, and the impacts of each alternative alone resulting from individual IPFs associated with these alternatives on other uses would still be **negligible** for cables and pipelines; **minor** for aviation and air traffic and radar systems; **minor** for most military and national security uses, but **moderate** for SAR activities; and **major** for scientific research and surveys.

In context of reasonably foreseeable environmental trends, combined impacts of Alternatives C, D1, and E on other uses from ongoing and planned actions would be very similar to those of Alternative A, because the majority of the impacts come from other offshore wind projects, and the impacts of each alternative alone would be very similar to those of Alternative A. In context of reasonably foreseeable environmental trends, ongoing and planned actions, including the impacts of Alternatives C, D1, or E, impacts would be **negligible** for cables and pipelines; **minor** for aviation and air traffic; **moderate** for radar systems; **minor** for most military and national security uses except SAR operations, which would be **major**; and **major** for scientific research and surveys. These impact ratings are driven primarily by the presence of offshore structures, primarily WTGs, in the RI and MA Lease Areas.

3.12.4. Consequences of Alternative D2

Impacts of Alternative D2 alone on other uses, reflecting the use of 14 MW WTGs, are summarized below. Alternative D2 would implement the 1 x 1 nautical mile layout and arrange WTGs with east-west rows and north-south columns. Alternative D2 would align the Vineyard Wind 1 Project layout with layouts of other adjacent offshore wind facilities, and with the layout distance and orientation recommended in the Final MARIPARS (USCG 2020b). Although the overall impact rating is the same as Alternative A, the Alternative D2 layout would increase navigational safety by allowing USCG to set predictable SAR patterns and successfully complete more SAR missions, thus avoiding fatalities that might otherwise occur with other WTG layouts. Therefore, the overall reported level of impact would remain similar to Alternative A, and the impacts of each alternative alone resulting from individual IPFs associated with these alternatives on other uses would still be **negligible** for cables and pipelines; **minor** for aviation and air traffic and radar systems; **minor** for most military and national security uses, but **moderate** for SAR activities; and **major** for scientific research and surveys. While the adjusted layout would improve safety for scientific survey and research vessels if and when they transit through the WDA, NOAA has indicated that research vessels are still not likely to traverse or sample within the WDA due to allision risk; therefore, the level of impact for Alternative D2 on scientific research and surveys remains **major**.

The revised project design envelope with the larger (i.e., 14 MW) WTGs would be the maximum impact scenario for other uses, primarily due to WTG height. These changes to the design capacity would not alter the maximum potential impacts of Alternative D2 on other uses. In addition, increasing the size of the proposed substation would not change the analysis of impacts on other uses included in the DEIS, due to the small acreage affected and the onshore location.

In context of reasonably foreseeable environmental trends, combined impacts from ongoing and planned actions, including Alternative D2, would be very similar to those of Alternative A (with the exception of SAR operations), because the majority of the impacts come from other offshore wind projects, and the impacts of this alternative alone would be very similar to those of Alternative A. In context of reasonably foreseeable environmental trends, the impacts from ongoing and planned actions, including Alternative D2, would be **negligible** for cables and pipelines;

minor for aviation and air traffic; **moderate** for radar systems; **minor** for most military and national security uses except SAR operations, which would be **moderate** and; and **major** for scientific research and surveys because research vessels are still not likely to traverse or sample within the leased areas. This is driven primarily by the presence of offshore structures, primarily WTGs, in the RI and MA Lease Areas.

3.12.5. Consequences of Alternative F

Compared to Alternative A alone, establishment of an up to 4-nautical-mile-wide transit lane through Alternative A layout under Alternative F could reduce impacts from IPFs related to risk of collisions and allisions for vessels by providing an up to 4-nautical-mile area through the WDA that is cleared of surface obstructions and aligned with the northwest-southeast WTG layout. BOEM's assessment indicates that a wider, 4-nautical-mile transit lane could reduce impacts more than the 2-nautical-mile transit lane assessed by providing a wider area clear of structures. Some recreational fishing vessels could congregate at structures alongside the transit lanes, possibly increasing risks of collisions and allisions in these areas. The implementation of 4-nautical-mile transit lanes may allow for some ship-based scientific research and survey activity to occur within the transit lanes if conditions are appropriate considering the survey type to be conducted, vessel traffic, presence of submerged cables, or other operational restrictions. Four nautical mile transit lanes could also allow survey vessels to transit through the wind development areas, reducing the loss of travel efficiency when survey vessels are transiting between survey stations, dependent on sea conditions. In comparison and for assessment purposes, a 2-nautical-mile transit lane would not provide these benefits for scientific surveys. However, changes to scientific research and survey methodologies would still be similar to those required under Alternative A and the magnitude of impacts would remain the same. Alternative F may reduce overall impacts on open-ocean navigation and vessel traffic, but would not change the overall impact magnitudes described for Alternative A. Therefore, the overall reported level of impact would remain similar to Alternative A, and the impacts of each alternative alone resulting from individual IPFs associated with these alternatives on other uses would still be **negligible** for cables and pipelines; **minor** for aviation and air traffic and radar systems; **minor** for most military and national security uses, but **moderate** for SAR activities; and **major** for scientific research and surveys.

Establishment of up to a 4-nautical-mile-wide transit lane through the Alternative D2 layout under Alternative F could result in increased impacts from IPFs related to allisions and collisions, including to military and national security vessels, but would reduce impacts on military and national security SAR activity. While, the presence of a transit lane could facilitate travel for vessels seeking to pass through the entire WDA the northwest-southeast transit lane orientation would differ from the east-west orientation of Vineyard Wind 1 WTGs. The differing orientations of the transit lane and WTG layout could increase navigational complexity for vessels operating within the area including military and national security vessels. Some commercial and recreational fishing and boating could occur within the transit lane, and recreational fishing vessels could congregate alongside the transit lanes, possibly increasing risks of collisions and allisions in these areas. This could lead to increased impacts on vessel traffic operating in the area including military and national security vessels; however, the magnitude of the impacts would remain the same as under Alternative A with either a 2- or a 4-nautical-mile-wide transit lane due to low military use of the WDA and the Department of Defense's evaluation that Alternative A in an older layout iteration (which did not provide transit lanes or a 1 x 1 nautical mile spacing) would have minor but acceptable impacts on military operations (Fred Engel, Pers. Comm., September 13, 2018). The implementation of the 4-nautical-mile northern transit lane with Alternative D2 may allow for some ship-based scientific research and survey activity to occur within the transit lane if conditions are appropriate considering the survey type to be conducted, vessel traffic, presence of submerged cables, or other operational restrictions. A 4-nautical-mile transit lane could also allow survey vessels to transit through the wind development areas, reducing the loss of travel efficiency when survey vessels are transiting between survey stations, dependent on sea conditions. In comparison and for assessment purposes, a 2-nautical-mile transit lane would not provide these benefits for scientific surveys. However, changes to scientific research and survey methodologies would still be similar to those required under Alternative A and the magnitude of impacts would remain the same. Alternative F with a 2- to 4-nautical-mile transit lane in combination with Alternative D2 would also have **negligible** impacts to cables and pipelines, **minor** impacts to aviation and air traffic and radar systems; **minor** impacts for most military and national security uses except SAR operations, which would be **moderate**; and **major** impacts on scientific research and surveys.

The impacts from the combination of the Alternative F with Alternative A or Alternative D2 is expected to be similar to combinations with the other action alternatives. Consequently, these other potential combinations are not separately analyzed here.

In considering the impacts of Alternative F in the context of reasonably foreseeable environmental trends, BOEM assumes for the purposes of this analysis that the transit lane through the Vineyard Wind lease area (OCS-A 0501) would continue to the southeast through Lease Areas OCS-A 0520 and OCS-A 0521 and northwest through Lease Area OCS-A 0500. As in the Vineyard Wind lease area, the no surface occupancy requirement would prevent these adjoining leases from locating structures such as WTGs and ESPs, and temporary site assessment buoys or towers, within transit lanes. This could result in the loss of 36 WTG locations with a 2-nautical-mile lane or 75 locations with a 4-nautical-mile lane. As in the Vineyard Wind lease area, BOEM assumes that the WTGs that would have been located within the transit lane would be shifted to locations south within the lease area and not eliminated from construction. The impact level is driven primarily by the presence of offshore structures, primarily WTGs, in the RI and MA Lease Areas and the transit lane would not eliminate WTGs in this area but would displace them. Therefore, in the context of reasonably foreseeable environmental trends, combined impacts from ongoing and planned actions, including Alternative F combined with Alternative A layout (as well as Alternative C, D1, and E), would remain similar to those described for Alternative A alone—**negligible** for aviation and air traffic; **minor** for cables and pipelines; **moderate** for radar systems, and **minor** for most military and national security uses except SAR operations, which would be **major**; and **major** for scientific research and surveys. In context of reasonably foreseeable environmental trends, combined impacts from ongoing and planned actions including Alternative F in combination with the Alternative D2 layout, would remain similar to those described for the Alternative D2 alone—**minor** for aviation and air traffic; **negligible** for cables and pipelines; **moderate** for radar systems; **minor** for most military and national security uses except SAR operations, which would be **moderate**; and **major** for scientific research and surveys.

BOEM's analysis of Alternative F focused on the implementation of RODA's northernmost transit lane through the WDA, and how that change to Alternative A would affect resources analyzed. The decision to implement RODA's six proposed transit lanes through the RI and MA Lease Areas is not the decision being evaluated in this FEIS; however, it is important to note that implementation of the additional five transit lanes through other lease areas would require no surface occupancy within those transit lanes, and other offshore wind project leaseholders could need to alter their site plans to relocate structures out of the transit lanes as well, specifically by locating WTGs further from shore, similar to the proposed Project as described in Section 2.1.5. There are several items to further consider with the implementation of all six corridors: (1) Vineyard Wind and other Rhode Island and Massachusetts offshore wind leaseholders have committed to implementing a 1 x 1 nautical mile WTG grid layout in east-west orientation (equivalent to Alternative D2) in response to stakeholder feedback. The RI and MA Lease Area developers' agreement was reached to avoid irregular transit corridors. With the implementation of the six corridors implemented as part of RODA's suggestion, the agreement to this standard layout for offshore renewable energy could be jeopardized; (2) offshore wind developers would need to alter their site plans to accommodate the six transit corridors, potentially causing construction delays that could create more overlap with other future offshore wind projects' construction schedules (Appendix A, Table A-6), potentially leading to increased effects to resources sensitive to overlapping construction activities; and (3) the addition of the 4-nautical-mile transit lanes proposed by RODA would reduce the technical capacity of the RI and MA Lease Areas by approximately 3,300 MW, which is 500 MW less than the current state demand for offshore wind in the area.[45]

[45] Approximately 775 WTGs are needed to meet existing state demand as considered in the expanded planned action scenario (57, 14 MW WTGs from the Proposed Action, plus 717, 12 MW WTGs for the remainder the proposed offshore wind projects in the RI and MA Lease Areas). Implementing RODA's six proposed transit lanes at a width of 2 nautical miles each would remove about 156 positions. Implementing RODA's six proposed 4-nautical-mile transit lanes would remove about 322 positions out of 1,059 possible foundation positions across the RI and MA Lease Areas due to surface occupancy restrictions, leaving about 737 positions available. Of those positions, approximately 14 would be occupied by ESPs, leaving 723 positions for WTGs, or 54 WTGs short of meeting the assumed demand. Total state demand for the RI and MA Lease Areas is assumed to be 9,404 MW, and technical capacity of the RI and MA Lease Areas is assumed to be 12,708 MW. The technical capacity of the remaining area after implementation of the transit lanes would be approximately 8,936 MW, leaving approximately 500 MW unfulfilled. Therefore, the total technical capacity loss in the RI and MA Lease Areas due to transit lanes proposed by RODA would be approximately 3,300 MW.

In the context of reasonably foreseeable environmental trends and planned actions, implementation of all RODA-recommended transit lanes across the RI and MA Lease Areas could potentially increase impacts related to allision and collision risk throughout all lease areas. The January 3, 2020, proposal from RODA was to establish a series of six transit lanes through the overall RI and MA Lease Areas (only one of which would affect the WDA) (RODA 2020). The USCG Final MARIPARS, published in May 2020, evaluated the RODA proposal for vessel traffic through the lease areas, and recommended all surface structures be aligned in a 1 x 1 nautical mile grid, such that vessels anywhere in the RI and MA Lease Areas would pass one WTG on either side every 1 nautical mile when traveling north-south or east-west, and every 0.6 to 0.8 nautical mile when traveling northwest-southeast or northeast-southwest (USCG 2020b). The Final MARIPARS did not recommend implementation of a wider transit lane. Some commercial and recreational fishing and boating could occur within the transit lanes, and recreational fishing vessels could congregate alongside the transit lanes, possibly increasing risks of collisions and allisions in these areas. Implementation of the 4-nautical-mile transit lanes may allow for some scientific research and survey activity to occur within the transit lane if conditions are appropriate considering the survey type to be conducted, vessel traffic, presence of submerged cables, or other operational restrictions. The 4-nautical-mile transit lanes could also allow survey vessels to transit through the wind development areas, reducing the loss of travel efficiency when survey vessels are transiting between survey stations, dependent on sea conditions. However, changes to scientific research and survey methodologies would still be required and the magnitude of impacts would remain the same.

3.12.6. Comparison of Alternatives

As discussed above, Alternative A and the action alternatives are similar in terms of the level of impact on other uses. Alternative C may slightly increase impacts on military and national security vessel and air traffic by moving additional turbines into military warning area W-105A. Alternative C could also potentially decrease impacts air traffic and aviation by moving WTGs farther away from regional airports and associated obstacle clearance surfaces, and placing them where obstacle clearance surfaces are higher in elevation. Alternatives D1 and D2 may slightly decrease risks associated with vessel allisions, vessel-related navigation hazards, and space use conflicts on the water. Alternative D2 would reduce potential impacts on military and national security SAR activity (i.e., avoiding some fatalities that might occur under other alternatives). Alternative E may slightly decrease impacts compared to the revised Proposed Action for military operations and national security, aviation and air traffic, radar systems, and scientific research and surveys due to use of shorter but more numerous WTGs, but the overall magnitude of impacts would not change for any resource. Installing 57 to 84 WTGs under Alternative E would have slightly greater impacts than Alternative A due to an increased number of WTGs and an increase in the developed area within the WDA. Alternative F would have smaller impacts for IPFs related to allision risks due to reduced impacts associated with structures and vessel collision; however, implementation of the northern transit corridor associated with Alternative F could have cascading effects on adjacent offshore wind leases. These differences would result in incrementally different impacts (in timing and location of impacts), but would not change the overall magnitude of impacts described for Alternative A. Furthermore, in context of reasonably foreseeable environmental trends, impacts under any action alternative including ongoing and planned actions would likely be very similar because the majority of the impacts of any alternative come from future offshore wind development, which does not change between alternatives, and because the differences in impacts among action alternatives would not result in different impact magnitudes. The exception would be that Alternative D2 and Alternative F combined with D2 would lower the overall impacts. See Table 2.4-1 for a comparison of alternative impacts.

3.12.7. Summary of Impacts of the Preferred Alternative

The Preferred Alternative would be a combination of Alternatives C, D2, and E with mitigation measures in Appendix D. Thus, no WTGs or inter-array cable would be placed within the northernmost portion of the WDA, more WTGs and inter-array cable may be placed in the southern portion of the WDA and may extend beyond the limits of the WDA proposed in the COP, although not beyond the boundaries of Lease Area OCS-0501, and no more than 84 WTGs would be allowed. The impacts associated with the Preferred Alternative on other uses would be anticipated as follows.

Military and National Security Uses: The level of impacts on military and national security uses are primarily driven by the number and arrangement of stationary structures (WTGs) to be installed in the WDA, and how they create navigational hazards and affect USCG SAR operations. Implementation of Alternative C could slightly increase impacts on military and national security vessel traffic and air traffic by moving additional turbines into military warning area W-105A. Alternative D2 would increase navigational safety, particularly for USCG SAR operations by implementing a 1 x 1 nautical mile layout and arranging WTGs with east-west rows and north-south columns, as recommended in the Final MARIPARS (USCG 2020b). Under Alternative E, between 57 and 84 WTGs would be installed in the WDA, with varying individual capacities designed to reach a total capacity of 800 MW. If a greater number of shorter WTGs are utilized, the impact would be incrementally somewhat smaller for military and national security uses due to a decrease in height of WTGs including those located in W-105A. Compared to Alternative A, none of these changes would change the overall level of impact, and impacts of the Preferred Alternative on military and national security uses are anticipated to be **minor** for most military and national security uses, and **moderate** for USCG SAR activities.

Aviation and Air Traffic: Potential impacts on aviation and air traffic would primarily be caused by installation of WTGs in the WDA, and also temporary positioning of construction cranes and WTGs under construction in the WDA, in ports, and along transit routes. Relocating the six northernmost WTG positions to the south of the WDA as proposed in Alternative C could potentially decrease impacts by moving WTGs farther away from regional airports and associated obstacle clearance surfaces, and placing WTGs where obstacle clearance surfaces are higher in elevation. The impacts of Alternative E would be incrementally somewhat smaller than the Alternative A for aviation and air traffic due to use of shorter WTGs. However, construction of a larger number of smaller-capacity turbines would still require similar measures to accommodate the proposed Project including coordination with military and national security entities and changes to air traffic navigational patterns. Compared to Alternative A, none of these differences would change the overall level of impact. The impacts of the Preferred Alternative on aviation and air traffic are therefore anticipated to be **minor**.

Cables and Pipelines: Potential impacts of the preferred alternative to cables and pipelines would be similar to Alternative A. Relocating the six northernmost WTG positions to the south of the WDA as proposed in Alternative C, implementing the design envelope contemplated for Alternative E would not alter impacts on cables and pipelines, and revising the layout as proposed in alternative D2 would not meaningfully change potential impacts on cables and pipelines, which would be **negligible**.

Radar Systems: Potential impacts on radar systems are primarily be caused by operation of offshore WTGs. Relocating the six northernmost WTG positions to the south of the WDA as proposed in Alternative C, and revising the layout as proposed in alternative D2 would not meaningfully change potential impacts on radar systems, because the WTGs would still be located a similar distance away. The impacts of Alternative E on radar systems could be incrementally somewhat smaller due to use of shorter WTGs. However, construction of a larger number of smaller-capacity turbines would still require similar measures to accommodate the proposed Project including coordination with military and national security entities and evaluation of potential impacts on radar systems. Compared to Alternative A, none of these changes would change the overall level of impact, and impacts of the Preferred Alternative on radar systems are anticipated to be **minor**.

Scientific Research and Surveys: The level of impacts on scientific research and surveys are primarily driven by the number and arrangement of stationary structures (WTGs) to be installed in the WDA, in addition to the installation of other project components such as cables, and how they create navigational hazards. These impacts would require entities conducting surveys and scientific research 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 and the commercial fisheries community. Relocating the six northernmost WTG positions to the south of the WDA as proposed in Alternative C, revising the layout as proposed in alternative D2, and implementing the design envelope contemplated for Alternative E would not meaningfully alter impacts on scientific research and surveys, which would remain **major** because impacts on vessel-based and aerial NOAA and NMFS surveys would remain the same as described for Alternative A. BOEM and NOAA are working collaboratively to develop mitigation to reevaluate survey methodology and future survey techniques.

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources, protecting our fish, wildlife and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.