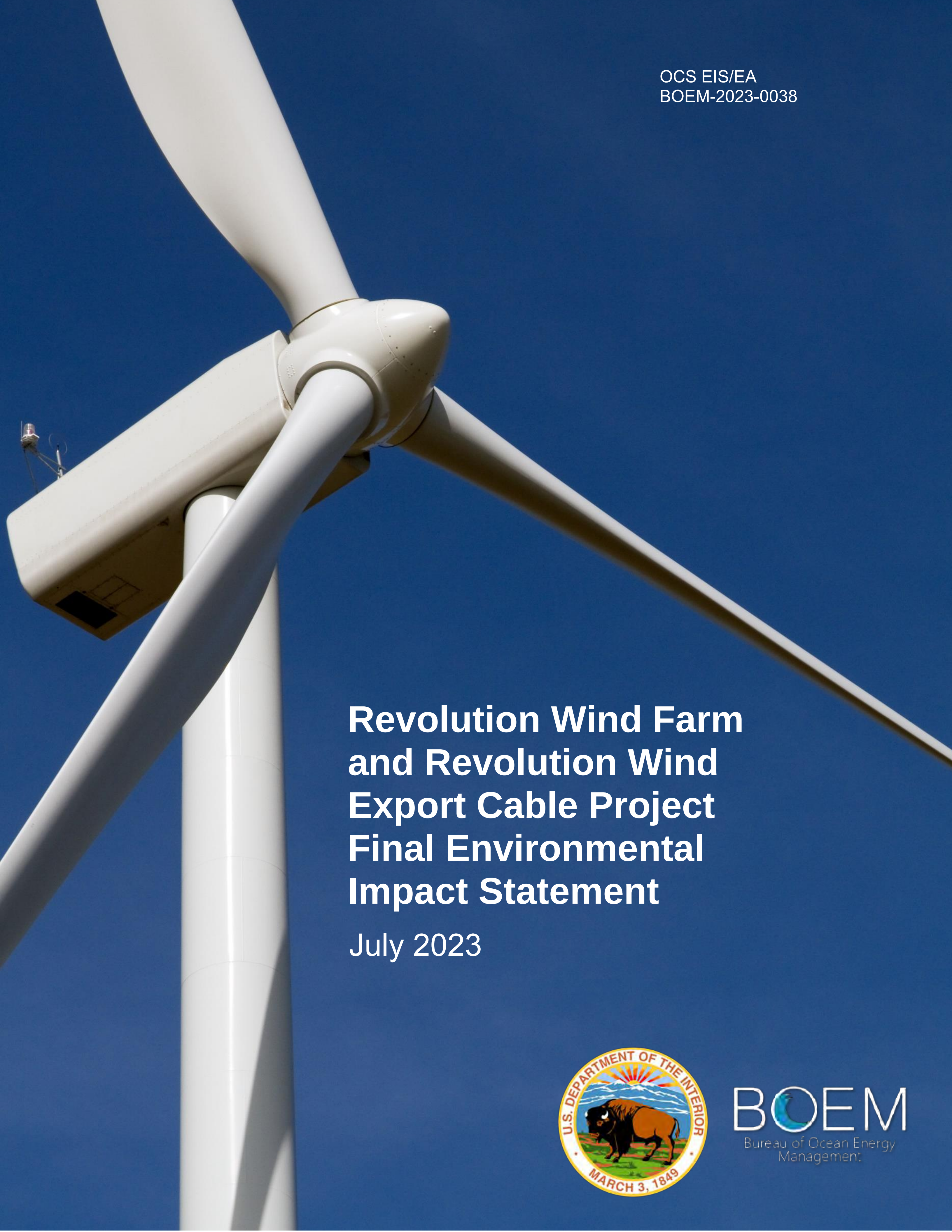

OCS EIS/EA
BOEM-2023-0038

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July 2023

U.S. Department of the Interior
BOEM
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Revolution Wind Farm and Revolution Wind Export Cable Project Environmental Impact Statement

Draft ( ) Final (X)

Lead Agency:	U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM)
Cooperating Federal Agencies:	National Oceanic and Atmospheric Administration, National Marine Fisheries Service U.S. Army Corps of Engineers U.S. Coast Guard U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement U.S. Environmental Protection Agency
Participating Federal Agencies:	Advisory Council on Historic Preservation Federal Aviation Administration National Park Service U.S. Department of Defense U.S. Department of Navy U.S. Fish and Wildlife Service
Cooperating State and Local Agencies:	Commonwealth of Massachusetts Massachusetts Office of Coastal Zone Management State of Rhode Island Rhode Island Coastal Resources Management Council Rhode Island Department of Environmental Management
Contact Person:	Laura Lee Wolfson National Environmental Policy Act Coordinator Office of Environment, Gulf of Mexico Regional Office Bureau of Ocean Energy Management 1201 Elmwood Boulevard New Orleans, Louisiana 70360 (703) 787-1433
Area:	Lease Area OCS-A 0486

Abstract:

This environmental impact statement (EIS) assesses the potential biological, socioeconomic, physical, and cultural impacts that could result from the construction, operations and maintenance, and decommissioning of the Revolution Wind Farm (RWF) and Revolution Wind Export Cable (RWEC) Project (the Project), as proposed by Revolution Wind, LLC (Revolution Wind), in its construction and operations plan. The Project would be located in the area covered by Bureau of Ocean Energy Management's (BOEM's) Renewable Energy Lease Number OCS-A 0486, approximately 15 nautical miles (nm) (18 statute miles) southeast of Point Judith, Rhode Island and approximately 13 nm (15 miles) east of Block Island, Rhode Island.

The Project is designed to contribute to Connecticut's mandate of 2,000 megawatts of offshore wind energy by 2030 and Rhode Island's 100% renewable energy goal by 2030. BOEM has prepared the EIS following the requirements of the National Environmental Policy Act (42 United States Code 4321–4370f) and implementing regulations. This EIS will inform BOEM in deciding whether to approve, approve with modifications, or disapprove the Project. Cooperating agencies will rely on the EIS to support their decision making and to determine if the analysis is sufficient to support their decision. BOEM's action furthers United States policy to make the Outer Continental Shelf energy resources available for development in an expeditious and orderly manner, subject to environmental safeguards (43 United States Code 1332(3)), including consideration of natural resources and existing ocean uses.

EXECUTIVE SUMMARY

This environmental impact statement (EIS) assesses the potential biological, socioeconomic, physical, and cultural impacts that could result from the construction, operations and maintenance (O&M), and decommissioning of the Revolution Wind Farm (RWF) and Revolution Wind Export Cable (RWEC) Project (the Project), as proposed by Revolution Wind, LLC (Revolution Wind), in its construction and operations plan (COP) (VHB 2023). The RWF COP is located on the Bureau of Ocean Energy Management (BOEM) webpage for the RWF Project at this link: https://www.boem.gov/renewable-energy/state-activities/revolution-wind. BOEM has prepared the EIS following the requirements of the National Environmental Policy Act (NEPA) (42 United States Code 4321 et seq.) and implementing regulations (40 Code of Federal Regulations 1500–1508). Additionally, this EIS was prepared consistent with the U.S. Department of the Interior's NEPA regulations (43 Code of Federal Regulations [CFR] 46), longstanding federal judicial and regulatory interpretations, and U.S. Administration priorities and policies including the Secretary of the Interior's (Secretary's) Order No. 3399 requiring bureaus and offices to not apply any of the provisions of the 2020 changes to Council on Environmental Quality regulations (the "2020 rule") (Council on Environmental Quality 2020) in a manner that would change the application or level of NEPA that would have been applied to a proposed action before the 2020 rule went into effect.

Cooperating agencies may rely on this EIS to support their decision-making. In conjunction with submitting its COP, Revolution Wind applied to the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) for an incidental take authorization in the form of a Letter of Authorization for Incidental Take Regulations under the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 USC 1361 et seq.), for incidental take of marine mammals during Project construction. Under the MMPA, NMFS is required to review applications and, if appropriate, issue an incidental take authorization. NMFS intends to adopt the Final EIS if, after independent review and analysis, NMFS determines the Final EIS to be sufficient to support its separate proposed action and decision to issue the authorization, if appropriate. The U.S. Army Corps of Engineers intends to adopt BOEM's EIS to support its decision on any permits requested under Section 10 of the Rivers and Harbors Act or Section 404 of the Clean Water Act.

Purpose and Need for the Proposed Action

Through a competitive leasing process under 30 CFR 585.211, Deepwater Wind New England, LLC, was awarded commercial Renewable Energy Lease OCS-A 0486 (Lease Area) covering an area offshore Rhode Island. Subsequent to the award of the Lease, BOEM approved an application to assign a portion of the Lease to Deepwater Wind South Fork, LLC, which resulted in the segregation of the Lease and a new lease number, OCS-A 0517, for that portion. Deepwater Wind South Fork, LLC, changed its name to South Fork Wind, LLC. The remaining portion of Lease OCS-A 0486 was assigned to DWW Rev I, LLC. DWW Rev I, LLC changed its name to Revolution Wind, LLC (Revolution Wind).

Revolution Wind's goal is to develop a commercial-scale offshore wind energy facility in the Lease Area with wind turbine generators (WTGs); a network of inter-array cables (IACs); up to two offshore substations (OSSs) (OSS1 and OSS2); up to two export cables making landfall in North Kingstown, Rhode Island; one onshore substation; and one interconnection facility. The Project is the Proposed Action considered by BOEM in this Final EIS. The need for the Project is to contribute to Connecticut's mandate of 2,000 megawatts (MW) of offshore wind energy by 2030, as outlined in Connecticut Public Act 19-71, and Rhode Island's 100% renewable energy goal by 2030, as outlined in Rhode Island Governor's Executive Order 20-01 of January 2020. The Project would have the capacity to deliver up to 880 MW of power to the New England energy grid, satisfying the current power purchase agreement (PPA) total of 704 MW. Specifically, Revolution Wind's goal to construct and operate a commercial-scale offshore wind energy facility in the Lease Area is intended to fulfill the following three PPAs:

1. A 200-MW contract with the State of Connecticut approved in January 2019
2. A 400-MW contract with the State of Rhode Island approved in June 2019
3. A 104-MW contract with the State of Connecticut approved in December 2019

Based on BOEM's authority under the Outer Continental Shelf Lands Act (OCSLA) to authorize renewable energy activities on the Outer Continental Shelf (OCS), and Executive Order 14008; the shared goals of the federal agencies to deploy 30 GW of offshore wind energy capacity in the United States by 2030, while protecting biodiversity and promoting ocean co-use (The White House 2021); and in consideration of the goals of the applicant, the purpose of BOEM's action is to determine whether to approve, approve with modifications, or disapprove Revolution Wind's COP. BOEM will make this determination after weighing the factors in subsection 8(p)(4) of the OCSLA that are applicable to plan decisions and in consideration of the above goals. BOEM's action is needed to fulfill its duties under the lease, which require BOEM to make a decision on the lessee's (Revolution Wind's) plans to construct and operate a commercial-scale offshore wind energy facility within the Lease Area (the Proposed Action).

The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) received a request for authorization to take marine mammals incidental to construction activities related to the Project, which NMFS may authorize under the Marine Mammal Protection Act (MMPA). NMFS's issuance of an MMPA incidental take authorization in the form of a Letter of Authorization (LOA) for Incidental Take Regulations (ITRs) is a major federal action and, in relation to BOEM's action, is considered a connected action (40 CFR 1501.9(e)(1)). The purpose of the NMFS action—which is a direct outcome of Revolution Wind's request for authorization to take marine mammals incidental to specified activities associated with the Project (e.g., pile driving)—is to evaluate Revolution Wind's request under requirements of the MMPA (16 USC 1371(a)(5)(A)) and its implementing regulations administered by NMFS and to decide whether to issue the authorization. NMFS needs to render a decision regarding the request for authorization due to NMFS's responsibilities under the MMPA (16 United States Code [USC] 1371(a)(5)(A and D)) and its implementing regulations. If NMFS makes the findings necessary to issue the requested authorization, NMFS intends to adopt, after independent review, BOEM's EIS to support that decision and fulfill its NEPA requirements. The U.S. Army Corps of Engineers (USACE) New England District anticipates requests for authorization of a permit action to be undertaken through authority delegated to the District Engineer by 33 CFR 325.8, pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) and Section 404 of the Clean Water Act (33 USC 1344). The USACE considers issuance of a permit under these two delegated authorities a major federal action connected to BOEM's Proposed Action (40 CFR 1501.9(e)(1)). USACE'S overall Project purpose for Section 404(b)(1) guidelines evaluation, as determined by the USACE, is the construction and operation of a commercial-scale offshore wind energy project, including associated transmission lines, for renewable energy generation and distribution to the Connecticut and Rhode Island energy grids. The

USACE intends to adopt BOEM's EIS to support its decision on any permits requested under Section 10 of the Rivers and Harbors Act or Section 404 of the CWA.

Public Involvement

Before the preparation of the EIS, BOEM conducted a 30-day public scoping period between April 30 and June 1, 2021, with an additional 7-day extension between June 4 and 11, 2021, following the correction of the notice of intent. During the public scoping period, BOEM held three public scoping virtual meetings via the Zoom webinar platform to solicit feedback and identify issues and potential alternatives for consideration. BOEM considered all scoping comments while preparing the draft EIS. Additional public input occurred during the Project's planning and leasing phases between 2010 and 2018. Publication of the draft EIS initiated a 45-day public comment period between September 2 and October 17, 2022, after which BOEM assessed and considered all the comments received in preparation of the final EIS. All public comments received on the draft EIS have been responded to by BOEM and are presented with their responses in Appendix L (Comments Received on Draft Environmental Impact Statement and BOEM's Responses to Public Comments on the Draft Environmental Impact Statement). See Appendix A (Required Environmental Permits and Consultations) for additional information on public involvement in the development of the EIS.

Alternatives

The EIS analyzes in detail a No Action alternative and six action alternatives, as briefly described in Table ES-1. Chapter 2 provides detailed descriptions of the analyzed alternatives.

Table ES-1. Alternative Descriptions

Alternative	Description
A: No Action Alternative	Under the No Action Alternative, BOEM would not approve the COP. Project construction and installation, O&M, and decommissioning would not occur, and no additional permits or authorizations for the Project would be required. Any potential environmental and socioeconomic impacts, including benefits, associated with the Project as described under the Proposed Action or the Preferred Alternative would not occur. However, all other past and ongoing impact-producing activities, including approved offshore wind projects (South Fork Wind Farm and Vineyard Wind), would continue. Under the No Action Alternative impacts to marine mammals incidental to construction activities would not occur. Therefore, NMFS would not issue the requested authorization under the MMPA to the applicant. The current resource condition, trends, and impacts from ongoing activities under the No Action Alternative serve as the baseline against which the direct and indirect impacts of all action alternatives are evaluated. Over the life of the proposed Project, other reasonably foreseeable future impact-producing offshore wind and non-offshore wind activities would be implemented, which would cause changes to the affected environment even in the absence of the Proposed Action or the Preferred Alternative. The continuation of all other existing and reasonably foreseeable future activities described in Appendix E (Planned Activities Scenario and Reasonably Foreseeable Future Activities and Projects) without the Proposed Action or any alternative

Alternative	Description
	action serves as the baseline against which the cumulative impacts of all action alternatives are evaluated.
B: Proposed Action Alternative (Proposed Action)	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the project design envelope (PDE) and implementation of applicable environmental protection measures (EPMs), as described in the COP. The Proposed Action would include up to 100 WTGs ranging in nameplate capacity of 8 to 12 MW sufficient to fulfill at a minimum the existing PPAs (total of 704 MW) up to 880 MW, the maximum capacity identified in the PDE. The WTGs would be connected by a network of IACs; up to two OSSs[1] connected by one OSS-link cable; up to two submarine export cables co-located within a single corridor; up to two underground transmission circuits located onshore; one onshore interconnection facility; and one onshore substation inclusive of up to two interconnection circuits connecting to the existing Davisville Substation in North Kingstown, Rhode Island. The Proposed Action includes the burial of offshore export cables below the seafloor in both the OCS and Rhode Island state waters and a uniform east-west and north-south grid of 1 × 1–nautical mile (nm) spacing between WTGs.[2]
C: Habitat Impact Minimization Alternative	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the COP. To reduce impacts to complex fisheries habitats most vulnerable to permanent and long-term impacts from the Proposed Action, however, certain WTG positions would be eliminated while maintaining a uniform east-west and north-south grid of 1 × 1–nm spacing between WTGs. The placement of WTGs would be supported by location-specific benthic and habitat characterizations conducted in close coordination with NMFS. Under Alternative C, fewer WTG locations (and potentially fewer miles of IACs) than the Proposed Action would be approved by BOEM. Under this alternative, there would be five "spare" WTGs: • Alternative C1: This alternative allows for the fulfillment of the existing three PPAs, which total 704 MW, while omitting WTGs in locations to maintain a uniform east-west and north-south grid of 1 × 1–nm spacing between WTGs. Under this alternative, up to 35 WTGs and associated IACs would be removed from consideration, resulting in up to 65 WTGs and associated IACs being approved. • Alternative C2: This alternative allows for the fulfillment of the existing three PPAs, which total 704 MW, while omitting WTGs in locations to maintain a uniform east-west and north-south grid of 1 × 1–nm spacing between WTGs. Under this alternative, up to 36 WTGs and associated IACs would be removed from consideration, resulting in up to 64 WTGs and associated IACs being approved. Refer to Appendix K (Supplemental Information on Alternatives Development) for background information on the development of the Alternative C1 and C2 layouts.

[1] Each OSS has a maximum nominal capacity of 440 MW; therefore, two OSSs are required to achieve the PPA obligations of 704 MW.

[2] In accordance with 30 CFR 585.634(c)(6), micrositing of WTG foundations may occur within 500 feet from each proposed WTG location. WTG micrositing would be performed on a case-by-case basis to avoid significant seafloor hazards such as surface and subsurface boulders (see COP Section 2.2.1.1).

Alternative	Description
D: No Surface Occupancy in One or More Outermost Portions of the Project Area Alternative	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the COP. However, to reduce conflicts with other competing space-use vessels, WTGs adjacent to or overlapping transit lanes proposed by stakeholders or the Buzzard's Bay Traffic Separation Scheme Inbound Lane would be eliminated while maintaining the uniform east-west and north-south 1 × 1–nm grid spacing between WTGs. Under Alternative D, BOEM could select one, all, or a combination of the following three alternatives, while still allowing for the fulfillment of existing PPAs and up to the maximum capacity identified in the PDE (i.e., 880 MW). Under this alternative, fewer WTG locations (and potentially fewer miles of IACs) than the Proposed Action would be approved by BOEM. Under this alternative, there would be up to six "spare" WTGs: • Alternative D1: Removal of the southernmost row of WTGs that overlap the 4-nm east-west transit lane proposed by the Responsible Offshore Development Alliance (RODA), as well as portions of Cox Ledge. Under this alternative, up to seven WTGs and associated IACs would be removed from consideration, resulting in up to 93 WTGs and associated IACs being approved. • Alternative D2: Removal of the eight easternmost WTGs that overlap the 4-nm north-south transit lane proposed by RODA. Under this alternative, up to eight WTGs and associated IACs would be removed from consideration, resulting in up to 92 WTGs and associated IACs being approved. • Alternative D3: Removal of the northwest row of WTGs adjacent to the Inbound Buzzards Bay Traffic Lane. Under this alternative, up to seven WTGs and associated IACs would be removed from consideration, resulting in up to 93 WTGs and associated IACs being approved. The selection of all three alternatives (i.e., D1, D2, and D3) would eliminate up to 22 WTG locations and associated IACs, resulting in up to 78 WTGs and associated IACs being approved while maintaining the 1 × 1–nm grid spacing proposed in the COP and as described in Alternative B. Based on the design parameters outlined in the COP, allowing for the placement of 78 to 93 WTGs and two OSSs would still allow for the fulfillment of up to the maximum capacity identified in the PDE (e.g., 880 MW = 74 WTGs needed if 12-MW WTGs are used).
E: Reduction of Surface Occupancy to Reduce Impacts to Culturally-Significant Resources Alternative	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the COP. However, to reduce the visual impacts on culturally important resources on Martha's Vineyard and in Rhode Island, some WTG positions would be eliminated while maintaining the uniform east-west and north-south 1 × 1–nm grid spacing between WTGs. Under Alternative E, fewer WTG locations (and potentially fewer miles of IACs) than the Proposed Action would be approved by BOEM. Under this alternative, there would be up to five "spare" WTGs: • Alternative E1: Allows for the fulfillment of the existing three PPAs totaling 704 MW, while eliminating WTG locations to reduce visual impacts on these culturally-important resources. Under this alternative, up to 36 WTGs and associated IACs would be removed from consideration, resulting in 64 WTGs and associated IACs being approved.

Alternative	Description
	• Alternative E2: Allows for a power output delivery identified in the PDE of up to 880 MW while eliminating WTG locations to reduce visual impacts on these culturally-important resources. Under this alternative, up to 19 WTGs and associated IACs would be removed from consideration, resulting in 81 WTGs and associated IACs being approved. Refer to Appendix K for background information on the development of the Alternative E1 and E2 layouts.
F: Selection of a Higher Capacity Wind Turbine Generator	The construction and installation, O&M, and eventual decommissioning of a wind energy facility implementing a higher nameplate capacity WTG (up to 14 MW) than what is proposed in the COP. This higher capacity WTG must fall within the physical design parameters of the PDE and be commercially available to the Project proponent within the time frame for the construction and installation schedule proposed in the COP. The number of WTG locations under Alternative F would be sufficient to fulfill the minimum existing PPAs (total of 704 MW and 56 WTGs, including up to five "spare" WTG locations). Using a higher capacity WTG would potentially reduce the number of foundations constructed to meet the purpose and need and thereby potentially reduce impacts to marine habitats and culturally significant resources and potentially reduce navigation risks.
G: Preferred Alternative	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the range of the design parameters outlined in the COP, subject to applicable EPMs. Alternative G (the Preferred Alternative) was designed to reduce impacts to visual resources and benthic habitat. This alternative would include up to 79 possible positions for the installation of 65 WTGs, which would range in nameplate capacity of 8 to 12 MW sufficient to fulfill at a minimum the existing PPAs (total of 704 MW) while maintaining the uniform east-west and north-south 1 × 1–nm grid spacing between WTGs. Under this alternative, there would be up to 14 "spare" WTG positions available for use if unforeseen siting conditions occur necessitating relocation of any of the 65 WTGs from the possible positions. Two of the 65 WTGs could be located in three different spots within the 79 WTG possible positions. As a result, Alternative G includes the analysis of three alternatives for installation of the 65 WTGs, G1–G3. This flexibility in design could allow for further refinement for visual resources impact reduction on Martha's Vineyard and Rhode Island, or for habitat impact reduction in the NMFS Priority 1 area. • Alternative G1: Allows for the fulfillment of the existing three PPAs totaling 704 MW, while relocating two WTG locations from a NMFS Priority 1 area to reduce fishery and essential fish habitat impacts. Under this alternative, 35 WTGs and associated IACs would be removed from consideration, resulting in 65 WTGs and associated IACs being installed in the positions identified under this alternative. • Alternative G2: Allows for the fulfillment of the existing three PPAs totaling 704 MW, while relocating two WTG locations to reduce visual impacts on the horizon from the Aquinnah Overlook, a culturally important resource. Under this alternative, 35 WTGs and associated IACs would be removed from consideration, resulting in 65 WTGs and associated IACs being installed in the positions identified under this alternative. • Alternative G3: Allows for the fulfillment of the existing three PPAs totaling 704 MW, while relocating two WTG locations closest to the shore of

Alternative	Description
	Martha's Vineyard to reduce visual impacts to this culturally important resource. Under this alternative, 35 WTGs and associated IACs would be removed from consideration, resulting in 65 WTGs and associated IACs being installed in the positions identified under this alternative. All other components of Alternative G are the same as the Proposed Action: two OSSs connected by an OSS-link cable; up to two submarine export cables co-located within a single corridor; up to two underground transmission circuits located onshore within a single corridor; and an onshore substation inclusive of up to two interconnection circuits within a single corridor connecting to the existing Davisville Substation in North Kingstown, Rhode Island. Refer to Appendix K for background information on the development of the Alternative G and Alternatives G1, G2, and G3.

Environmental Impacts

The EIS uses a four-level classification scheme to characterize the potential adverse or beneficial impacts of alternatives as either **negligible**, **minor**, **moderate**, or **major**. Chapter 2, Section 2.3, provides a summary and comparison of the impacts under the No Action Alternative and each action alternative assessed in Chapter 3, which is provided below as Table ES-2. Under the No Action Alternative, any potential environmental and socioeconomic impacts, including benefits, associated with the Proposed Action or Preferred Alternative would not occur; however, impacts could occur from other ongoing and planned activities. This table also provides a summary of the overall cumulative impacts by environmental resource and alternative. Impacts include both Project-specific impacts and incremental impacts of the Project when combined with other current and reasonably foreseeable projects (i.e., cumulative impacts). Where directionality (e.g., adverse or beneficial) is not specifically noted, the reader should assume the impact is adverse. Impacts associated with the other action alternatives are generally similar to those described for the Proposed Action.

In Table ES-2, green cell color represents negligible to minor adverse overall impact. Yellow cell color represents moderate adverse overall impact. Orange cell color represents major adverse overall impact. Resources with beneficial impacts are denoted by an asterisk, and alternatives within those resource rows with beneficial impacts are denoted by a bolded blue outline and an asterisk. See Section 3.3 for additional information on impact level definitions. Detailed comparisons of both adverse and beneficial impacts by environmental resource and alternative, as well as evaluation of impacts across alternatives, are provided in each resource area within Chapter 3 (Sections 3.4 through 3.22).

BOEM analyzes the impacts of past and ongoing activities in the absence of the Project as the No Action Alternative. The No Action Alternative serves as the baseline against which all action alternatives are evaluated. BOEM also separately analyzes cumulative impacts of the No Action Alternative, which considers all other ongoing and reasonably foreseeable future activities described in Appendix E. In this analysis, the cumulative impacts of the No Action Alternative serve as the affected environment against which the cumulative impacts of all action alternatives are evaluated.

Council on Environmental Quality NEPA implementing regulations (40 CFR 1502.16) require that an EIS evaluate the potential for 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 I (Other Impacts) describes these potential unavoidable adverse impacts. Most potential unavoidable adverse impacts associated with the Proposed Action would occur during the construction phase and would be temporary. Appendix I also describes irreversible and irretrievable commitment of resources by resource area. The most notable such commitments could include effects on habitat or individual members of protected species, as well as potential loss of use of commercial fishing areas.

Table ES-2. Comparison of Alternatives and Overall Cumulative Impacts by Alternative

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Air quality – Alternative impacts*	Continuation of current air quality trends and sources of air pollution would be **moderate** adverse.	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*
Air quality: – Cumulative impacts*	**Minor** to **moderate** adverse; **minor** to **moderate** beneficial*	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse
Bats: Alternative impacts	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **negligible** adverse.	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse
Bats: Cumulative impacts	**Negligible** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Benthic habitat and invertebrates: Alternative impacts*	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **minor** to **moderate** adverse.	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*
Benthic habitat and invertebrates: Cumulative impacts*	**Minor** to **moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*
Birds: Alternative impacts	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **minor** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Birds: Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Coastal habitats and fauna: Alternative impacts	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **negligible** adverse.	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse
Coastal habitats and fauna: Cumulative impacts	**Negligible** to **minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Commercial fisheries and for-hire recreational fishing: Alternative impacts*	Continuation of current trends would be **moderate** to **major** adverse for commercial fisheries and **minor** to **moderate** adverse and **minor** beneficial for for-hire recreational fishing.*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*
Commercial fisheries and for-hire recreational fishing: Cumulative impacts*	**Moderate** to **major** adverse for commercial fisheries; **minor** to **moderate** adverse and **minor** beneficial for for-hire recreational fishing*	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse
Cultural resources: Alternative impacts	Continuation of individual IPF impacts to cultural resources from past and current activities would be **negligible** to **major** negative.[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]
Cultural resources: Cumulative impacts	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]	**Negligible** to **major** negative[†]
Demographics, employment, and economics: Alternative impacts*	Continuation of current trends would be **moderate** to **major** adverse and **minor** to **moderate** beneficial.*	**Negligible** to **moderate** adverse; **minor** beneficial*	**Minor** beneficial*	**Minor** beneficial*	**Minor** beneficial*	**Minor** beneficial*	**Minor** beneficial*
Demographics, employment, and economics: Cumulative impacts*	**Major** adverse; **minor** to **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*
Environmental justice: Alternative impacts*	Continuation of current trends would be **negligible** to **major** adverse and **negligible** to **moderate** beneficial.*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*
Environmental justice: Cumulative impacts	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse
Finfish and essential fish habitat: Alternative impacts*	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **moderate** adverse.	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*
Finfish and essential fish habitat: Cumulative impacts*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*

Resource	**Alternative A (No Action Alternative)**	**Alternative B (Proposed Action)**	**Alternative C (Habitat Alternative)**	**Alternative D (Transit Alternative)**	**Alternative E (Viewshed Alternative)**	**Alternative F (Higher Capacity Turbine Alternative)**	**Alternative G (Preferred Alternative)**
Land use and coastal infrastructure: Alternative impacts*	Continuation of current trends would be **minor** adverse.	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*
Land use and coastal infrastructure: Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Marine mammals: Alternative impacts*	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **moderate** adverse for all marine mammals except for the North Atlantic right whale (NARW). Continuation of population trends and human-caused stressors would be **major** for NARW.	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*
Marine mammals: Cumulative impacts*	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)
Navigation and vessel traffic: Alternative impacts	Continuation of current trends would be **minor** to **moderate** adverse.	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Minor** to **moderate** adverse	**Moderate** adverse	**Minor** to **moderate** adverse
Navigation and vessel traffic: Cumulative impacts	**Minor** to **moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse
Other marine uses: aviation and air traffic: Alternative impacts	Continuation of current trends would be **negligible** adverse.	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse
Other marine uses: aviation and air traffic: Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Other marine uses: land-based radar: Alternative impacts	Continuation of current trends would be **negligible** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Other marine uses: land-based radar: Cumulative impacts	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse
Other marine uses: military and national security: Alternative impacts	Continuation of current trends would be **negligible** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Other marine uses: military and national security: Cumulative impacts	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse
Other marine uses: scientific research and surveys: Alternative impacts	Continuation of current trends would be **moderate** adverse.	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse
Other marine uses: scientific research and surveys: Cumulative impacts	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse
Other marine uses: undersea cables: Alternative impacts	Continuation of current trends would be **negligible** adverse.	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse
Other marine uses: undersea cables: Cumulative impacts	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse
Recreation and tourism: Alternative impacts	Continuation of current trends would be **minor** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Recreation and tourism – Cumulative impacts*	**Minor** adverse	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*
Sea turtles: Alternative impacts*	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **minor** adverse.	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*
Sea turtles: Cumulative impacts*	**Minor** adverse; **minor** beneficial*	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Visual resources: Alternative impacts	Continuation of impacts to viewsheds from past and current activities would be **negligible** to **moderate** adverse.	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse
Visual resources: Cumulative impacts	**Moderate** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse
Water quality – Alternative impacts	Continuation of current water quality trends and sources of pollution would be **minor** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Water quality – Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Wetlands and non-tidal waters: Alternative impacts	Continuation of current wetland resources trends and sources of pollution would be **negligible** adverse.	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse
Wetlands and non-tidal waters: Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse

* Resources with beneficial impacts are denoted by an asterisk, and alternatives within those resource rows with beneficial impacts are denoted by a bolded blue outline and an asterisk.

† The term "adverse" has a specific meaning under NHPA Section 106 regulations (in 36 CFR 800.5) and, therefore, to remove confusion in the Cultural Resources section, the terms "negative" and "beneficial" are used in the identification of impacts under NEPA.

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Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
$\mu m/s^2$	micrometers per second squared
μPa	micropascal
μPa^2	micropascal squared
$\mu Pa/sec^2$	micropascal per second squared
μV	microvolt
ABMP	avian and bat monitoring plan
AC	alternating current
ADLS	aircraft detection lighting system
AGL	above ground level
AIS	Automatic Identification System
amsl	above mean sea level
ANSI	American National Standards Institute
APE	area of potential effects
AQRV	air quality related values
ASMFC	Atlantic States Marine Fisheries Commission
ASL	above sea level
ASR	airport surveillance radar
ATON	aid to navigation
AVERT	AVoided Emissions and geneRation Tool
BA	biological assessment
BACI	before-and-after-control-impact
BCC	Birds of Conservation Concern
BID	Block Island State Airport
BiOp	biological opinion
BIWF	Block Island Wind Farm
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BRI	Biodiversity Research Institute
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CBRA	Cable Burial Risk Assessment
CEQ	Council on Environmental Quality

CFR	Code of Federal Regulations
cm	centimeter
CMECS	Coastal and Marine Ecological Classification System
CMR	Collision Minimization Report
CO	carbon monoxide
CO_2e	carbon dioxide equivalents
COBRA	CO-Benefits Risk Assessment
COP	construction and operations plan
CTV	crew transport vessel
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
cy	cubic yards
dB	decibels
dBA	A-weighted decibels
dB re 1 µPa	decibels referenced to a pressure of one micropascal
dB re 1 μPa^2s	decibels referenced to the sum of cumulative pressure in micropascals squared, normalized to 1 second
dB_{RMS}	root mean square decibels
DMA	dynamic management area
DO	dissolved oxygen
DOD	U.S. Department of Defense
DOI	U.S. Department of the Interior
DME	distance-measuring equipment
DP	dynamic positioning
DPS	distinct population segment
EA	environmental assessment
EFH	essential fish habitat
EIS	environmental impact statement
EO	Executive Order
ECO Edison	Edison Chouest Offshore
EMF	electromagnetic field
eNGO	environmental non-governmental organization
EPA	U.S. Environmental Protection Agency
EPM	environmental protection measure
ERM	Environmental Resource Map
ESA	Endangered Species Act

EWR	early warning radar
FAA	Federal Aviation Administration
FDR	facility design report
FGDC	Federal Geographic Data Committee
FHWG	Fisheries Hydroacoustic Working Group
FMP	fishery management plan
FONSI	finding of no significant impact
FRMP	fisheries research and monitoring plan
FTE	full-time equivalent
GAA	geographic analysis area
GARFO	Greater Atlantic Regional Fisheries Office
G&G	geological and geophysical
GDP	gross domestic product
GHG	greenhouse gas
GUS	Get Up Safe system
GW	gigawatt
HAPC	Habitat Area of Particular Concern
hazmat	hazardous materials
HDD	horizontal directional drilling
HF	high frequency
HFC	high-frequency cetaceans
HMS	highly migratory species
HRG	high-resolution geophysical
HRVEA	historic resources visual effects assessment
HVAC	high-voltage alternating current
HVDC	high-voltage direct current
Hz	hertz
IAC	inter-array cable
ICF	interconnection facility
IHA	Incidental Harassment Authorization
IMO	International Maritime Organizatio
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPaC	Information for Planning and Consultation
IPF	impact-producing factor
ITA	Incidental Take Authorization

ITR	Incidental Take Regulation
IWG	Interagency Working Group on Social Cost of Greenhouse Gases
JEDI-OWM	Jobs and Economic Development Impacts Offshore Wind Model
kHz	kilohertz
kJ	kilojoule
km	kilometer
km^2	square kilometers
KOP	key observation point
kV	kilovolt
LCA	Landscape Character Area
Lease	Commercial Lease OCS-A 0486
Lease Area	Lease Number OCS-A 0486
Leq	equivalent sound level
LGL	LGL Ecological Research Associates
LOA	Letter of Authorization
LOS	level of service
Lpk	zero-to-peak sound pressure level
Lrms	root-mean-square sound pressure level (also SPL)
LFC	low-frequency cetaceans
m	meter
m3	cubic meter
MA CZM	Massachusetts Office of Coastal Zone Management
MAFMC	Mid-Atlantic Fishery Management Council
MARA	marine archaeological resources assessment
MARCO	Mid-Atlantic Regional Council on the Ocean
MARIPAS	Massachusetts and Rhode Island Port Access Study
MARPOL	International Convention for the Prevention of Pollution from Ships
MA WEA	Massachusetts Wind Energy Area
MBTA	Migratory Bird Treaty Act
MDAT	Marine-life Data and Analysis Team
MEC	munitions and explosives of concern
met	meteorological
MFC	mid-frequency cetaceans
mG	milligauss
mg/L	milligrams per liter

mg/m^3	microgram per cubic meter
MHC	Massachusetts Historical Commission
mm	millimeter
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOA	memorandum of agreement
MOU	memorandum of understanding
m/s	meters/second
MVAs	minimum vectoring altitudes
MVCO	Martha's Vineyard Coastal Observatory
mV/m	millivolt/meter
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NABCI	North American Bird Conservation Initiative
NARW	North Atlantic right whale
NEFMC	New England Fishery Management Council
NEFOP	Northeast Fisheries Observer Program
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar
NH_3	ammonia
NHL	national historic landmark
NHPA	National Historic Preservation Act
nm	nautical mile
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOA	notice of availability
NOAA	National Oceanic and Atmospheric Administration
NOI	notice of intent
NO_x	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NREL	National Renewable Energy Laboratory
NSRA	navigational safety risk assessment
NWR	National Wildlife Refuge

NYMRC	New York Marine Rescue Center
NYSERDA	New York State Energy Research and Development Authority
O&M	operations and maintenance
O_3	ozone
OBIS-SEAMAP	Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations
OCA	Ocean Character Area
OCM	Office for Coastal Management
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OMB	Office of Management and Budget
OnSS	onshore substation
OSAMP	Ocean Special Area Management Plan
OSRP	oil spill response plan
OSS	offshore substation
OSS-link cable	offshore substation-link cable
OSW	offshore wind
OTR	Ozone Transport Region
PAL	Public Archaeology Laboratory, Inc.
PAM	passive acoustic monitoring
PATON	private aids to navigation
PMB	potential biological removal
PCBs	polychlorinated biphenyls
PDE	project design envelope
PM_{10}	particulate matter 10 microns or less
$PM_{2.5}$	particulate matter 2.5 microns or less
PMEL	Pacific Marine Environmental Laboratory
POWERON	Partnership for an Offshore Wind Energy Regional Observation Network
PPA	power purchase agreements
ppb	parts per billion
ppm	parts per million
Project	Revolution Wind Farm and Revolution Wind Export Cable Project
PSO	protected species observer
psu	practical salinity unit
PTS	permanent threshold shift
PVD	Providence

RAM	Radar Adverse-impact Management
Revolution Wind	Revolution Wind, LLC
RFA	Regional Fisheries Area
RICR	Rhode Island Code of Regulations
RI CRMC	Rhode Island Coastal Resources Management Council
RIHPHC	Rhode Island Historic Preservation and Heritage Commission
RI/MA WEA	Rhode Island/Massachusetts Wind Energy Area
RIDEM	Rhode Island Department of Environmental Management
RIEMC	Rhode Island Environmental Monitoring Collaborative
RINHP	Rhode Island Natural Heritage Program
RIPDES	Rhode Island Pollutant Discharge Elimination System
RIWAP	Rhode Island Wildlife Action Plan
rms	root mean square
RMP	reasonable and prudent measure
ROD	record of decision
RODA	Responsible Offshore Development Alliance
ROW	right-of-way
RSZ	rotor swept zone
RWEC	Revolution Wind Export Cable
RWEC-OCS	RWEC offshore segment in federal waters
RWEC-RI	RWEC offshore segment in state waters
RWF	Revolution Wind Farm
RWSC	Regional Wildlife Science Collaborative for Offshore Wind
SAP	site assessment plan
SAR	search and rescue
SAV	submerged aquatic vegetation
SCA	Seascape Character Area
SCADA	supervisory control and data acquisition
SCRAM	Stochastic Collision Risk Assessment for Movement
SC-GHG	Social Cost of Greenhouse Gases
Secretary	Secretary of the Interior
SEFSC	Southeast Fisheries Science Center
SEL	sound exposure level
SESC	soil erosion and sedimentation control
SF_6	sulfur hexafluoride

SFEC	South Fork Export Cable
SFV	sound field verification
SFWF	South Fork Wind Farm
SIP	state implementation plan
SLIA	seascape and landscape impacts assessment
SLVIA	seascape, landscape, and visual impacts assessment
SMA	seasonal management area
SO_2	sulfur dioxide
SOV	service operations vessel
SPCC	spill prevention, control, and countermeasures
SPL	root-mean-square sound pressure level (also Lrms)
STSSN	Sea Turtle Stranding and Salvage Network
T&C	terms and conditions
TARA	terrestrial archaeological resources assessment
TCP	traditional cultural places
THPO	tribal historic preservation office
TJB	transition joint bay
TNEC	The Narragansett Electric Company d/b/a Rhode Island Energy
TOY	time of year
tpy	tons per year
TRACON	Terminal Radar Approach Control
TSS	total suspended solid
TTS	temporary threshold shift
UDP	Unanticipated Discovery Plan
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
VFR	Visual Flight Rules
VIA	visual impact assessment
VMS	vessel monitoring system
VOC	volatile organic compound
VOR	VHF omnidirectional range

VTR	vessel trip report
WEA	wind energy area
WOTUS	waters of the United States
WSDOT	Washington State Department of Transportation
WTG	wind turbine generator

1 Introduction

This environmental impact statement (EIS) assesses the potential biological, socioeconomic, physical, and cultural impacts that could result from the construction, operations and maintenance (O&M), and decommissioning of the Revolution Wind Farm (RWF) and Revolution Wind Export Cable (RWEC) Project (the Project), as proposed by Revolution Wind, LLC (Revolution Wind) (formerly DWW Rev I, LLC) in its construction and operations plan (COP) (VHB 2023). The Project would be located in the Bureau of Ocean Energy Management's (BOEM) Renewable Energy Lease Number OCS-A 0486 (Lease Area) approximately 15 nautical miles (nm) (18 statute miles[1]) southeast of Point Judith, Rhode Island; approximately 13 nm (15 miles) east of Block Island, Rhode Island; approximately 7.5 nm (8.5 miles) south of Nomans Land Island National Wildlife Refuge (NWR) (uninhabited island); and between approximately 10.0 and 12.5 nm (12 and 14 miles) south-southwest of varying points of the Rhode Island and Massachusetts coastlines 15.0 miles east of Block Island, Rhode Island (Figure 1.1-1).

The RWF would include up to 100 wind turbine generators (WTGs or turbines) connected by a network of inter-array cables (IACs), up to two offshore substations (OSSs) connected by one offshore substation-link cable (OSS-link cable), and one onshore logistics or O&M facility. The RWEC would include up to two alternating current (AC) electric cables (export cables) generally co-located within a single corridor; one onshore substation (OnSS); and one interconnection facility (ICF) that would connect the RWF to the existing onshore regional electric transmission grid at The Narragansett Electric Company d/b/a Rhode Island Energy (TNEC) Davisville Substation in North Kingstown, Rhode Island.

This EIS was prepared following the requirements of the National Environmental Policy Act (NEPA) (42 United States Code [USC] 4321 et seq.) and implementing regulations (40 Code of Federal Regulations [CFR] 1500–1508).[2] Additionally, this EIS was prepared consistent with the U.S. Department of the Interior's (DOI's) NEPA regulations (43 CFR 46), longstanding federal judicial and regulatory interpretations, and U.S. Administration priorities and policies including the Secretary of the Interior's (Secretary's) Order No. 3399 requiring bureaus and offices to not apply any of the provisions of the 2020 changes to CEQ regulations (the "2020 rule") (CEQ 2020) in a manner that would change the application or level of NEPA that would have been applied to a proposed action before the 2020 rule went into effect.

The Final EIS will inform BOEM in deciding whether to approve, approve with modifications, or disapprove the proposed Project. Publication of the Draft EIS initiated a 45-day public comment period. Comments received during the public comment period were assessed and considered by BOEM in preparing the Final EIS.

1.1 Background

The history of BOEM's planning and leasing activities offshore Rhode Island is summarized in Table 1.1-1. On March 13, 2020, Revolution Wind (formerly DWW Rev I, LLC) submitted an initial Project COP to

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[1] In this EIS, distances in miles are in statute miles (miles used in the traditional sense) or nautical miles (miles used specifically for marine navigation). Statute miles are more commonly used and are referred to simply as miles, whereas nautical miles are referred to by name or by the abbreviation *nm*. 1 nautical mile (nm) equals 1.15 statute miles.

[2] This EIS is being prepared using the 2020 CEQ NEPA Regulations. The effective date of the 2020 CEQ NEPA Regulations was September 14, 2020, and reviews begun after this date are required to apply the 2020 regulations unless there is a clear and fundamental conflict with an applicable statute (CEQ 2020) (85 *Federal Register* 43372–43373 [40 CFR 1506.13 and 1507.3(a)]). This EIS began on April 30, 2021, and accordingly proceeds under the 2020 regulations.

BOEM. After multiple BOEM reviews and revisions to address BOEM's comments, Revolution Wind submitted an updated COP on April 29, 2021, deemed sufficient to begin the NEPA process, which BOEM initiated on April 30, 2021, with issuance of the notice of intent (NOI) (BOEM 2021a). As described in Appendix A (Required Environmental Permits and Consultations) the initial public scoping period occurred from April 30 through June 1, 2021. On June 4, 2021, BOEM issued a correction to the NOI with a reopening of the public scoping period through June 11, 2021 (BOEM 2021b).

Table 1.1-1. History of Bureau of Ocean Energy Management Planning and Leasing Offshore Rhode Island Related to Lease OCS-A 0486

Year	Milestone
2011	On August 18, 2011, BOEM published a Call for Information and Nominations (Call) for commercial leasing for wind power on the Outer Continental Shelf (OCS) offshore Rhode Island and Massachusetts in the *Federal Register* (BOEM 2011). The public comment period for the Call closed on October 3, 2011. In conjunction with the Call, BOEM published an NOI to prepare an environmental assessment (EA) on the proposed leasing and on-site characterization and assessment activities in the offshore area under consideration in the Call. BOEM received eight indications of interest to obtain a commercial lease for a wind energy project, 81 comments on the Call, and 24 comments in response to the NOI.
2012	On February 24, 2012, BOEM announced the Rhode Island/Massachusetts Wind Energy Area[3] (RI/MA WEA) (Figure 1.1-2.), which comprises approximately 164,750 acres within an area of mutual interest identified by Rhode Island and Massachusetts in a memorandum of understanding (MOU) between the two states in 2010 (State of Rhode Island and the Commonwealth of Massachusetts 2010). BOEM published a proposed sale notice in the *Federal Register* on December 3, 2012, for a 60-day public comment period (BOEM 2012).
2013	On June 4, 2013, BOEM made available a revised EA for the RI/MA WEA. As a result of the analysis in the revised EA, BOEM issued a finding of no significant impact (FONSI), which concluded that reasonably foreseeable environmental effects associated with the commercial wind lease issuance and related activities would not significantly affect the environment. On June 5, 2013, BOEM published a final sale notice to auction two leases in the RI/MA WEA for commercial wind energy development (BOEM 2013a). On July 31, 2013, BOEM auctioned the two lease areas announcing Deepwater Wind New England LLC as the winner of both. BOEM issued Renewable Energy Lease Area OCS-A 0486 (Lease Area) to the applicant on October 1, 2013 (BOEM 2013b).
2016	A site assessment plan (SAP) for Lease Area OCS-A 0486 was filed on April 1, 2016, with revisions filed in July, September, and November 2016. BOEM determined the SAP was complete on October 7, 2016.
2017	On October 12, 2017, BOEM approved the SAP for Lease Area OCS-A 0486.

[3] BOEM works with its federal, state, local, and tribal partners to identify WEAs of the OCS that appear most suitable for commercial wind energy activities, while presenting the fewest apparent environmental and user conflicts (BOEM 2022a). Once WEAs are identified, BOEM conducts EAs under NEPA to determine potential impacts associated with issuing one or more leases within a WEA. BOEM may then move forward with steps to hold a competitive lease sale for commercial wind development within the WEAs. The Project is located in BOEM Lease Area OCS-A 0486, which is located in the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA). The RI/MA WEA is adjacent to and west of the Massachusetts Wind Energy Area (MA WEA) (see Figure 1.1-2). More information on BOEM WEAs, including maps, are found on the BOEM website: https://www.boem.gov/renewable-energy/state-activities.

Year	Milestone
2020	On January 10, 2020, a request was made to BOEM to segregate Lease Area OCS-A 0486 to accommodate both the RWF and RWEC Project and the South Fork Wind Farm (SFWF) and South Fork Export Cable (SFEC) Project. The RWF and RWEC Project retained lease number OCS-A 0486, whereas a new lease number was assigned for the SFWF and SFEC Project (OCS-A 0517). Revolution Wind submitted its initial COP to BOEM on March 13, 2020.
2021	Revolution Wind submitted its updated COP on April 29, 2021. On April 30, 2021, BOEM published in the *Federal Register* an NOI to prepare an EIS for Revolution Wind's proposed wind energy facility offshore Rhode Island (BOEM 2021a). On June 4, 2021, BOEM issued a correction to the NOI with a reopening of the public scoping period (BOEM 2021b). The correction addressed and clarified two statements in the NOI regarding the energy capacity of the proposed wind farm and its distance from shore. In addition, the NOI correction reopened the comment period, allowing for comments to be received by June 11, 2021. Updated versions of the COP were submitted on December 15, 2021.
2022	Revolution Wind submitted an updated version of the COP on July 21, 2022. On September 2, 2022, BOEM published a notice of availability (NOA) in the *Federal Register* for the Draft EIS for public review and comment (BOEM 2022b). The NOA included times and locations for public hearings and the comment period end date of October 17, 2022.
2023	Revolution Wind submitted an updated version of the COP on March 1, 2023. BOEM anticipates publishing a notice of availability (NOA) in the *Federal Register* for the Final EIS on July 21, 2023.

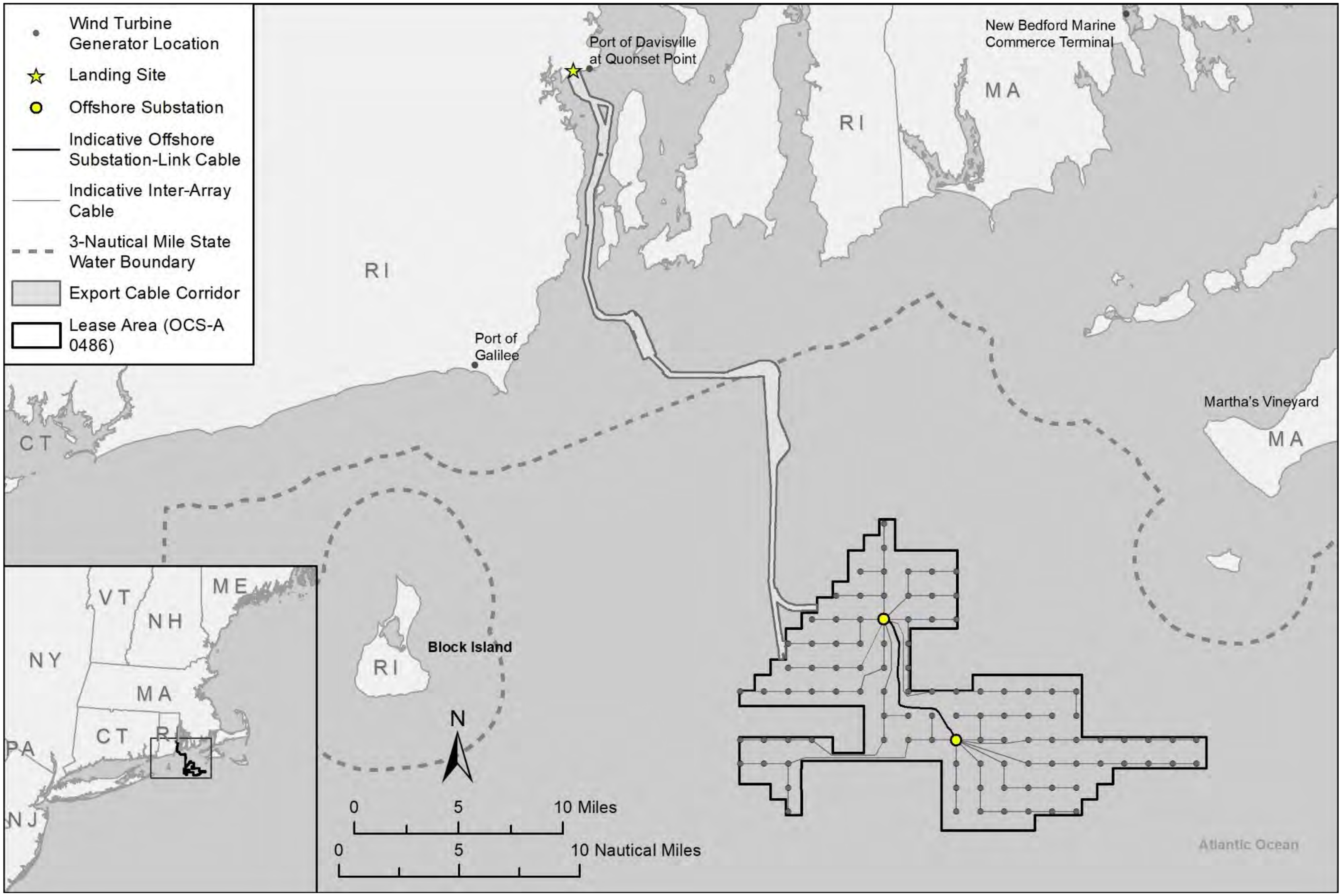

Figure 1.1-1. Project overview.

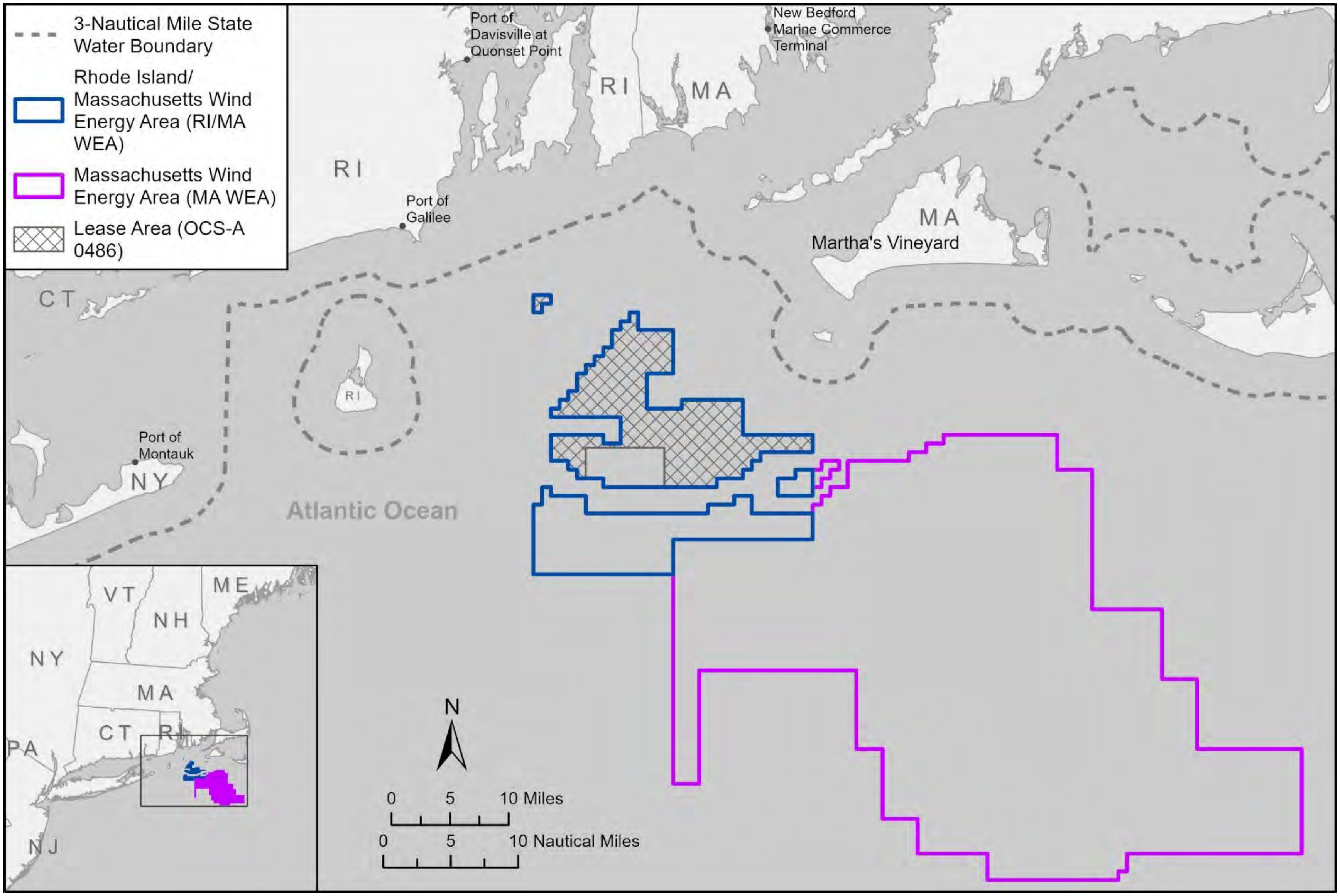

Figure 1.1-2. New England wind energy areas.

1.2 Purpose and Need for the Proposed Action

In Executive Order (EO) 14008 (Tackling the Climate Crisis at Home and Abroad), President Joseph Biden states that it is the policy of the United States to

> organize and deploy the full capacity of its agencies to combat the climate crisis to implement a Government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers environmental justice; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure.

Through a competitive leasing process under 30 CFR 585.211, Deepwater Wind New England, LLC was awarded commercial Renewable Energy Lease OCS-A 0486 (Lease Area) covering an area offshore Rhode Island (Table 1.1-1). Subsequent to the award of the Lease, BOEM approved an application to assign a portion of the Lease to Deepwater Wind South Fork, LLC, which resulted in the segregation of the Lease and a new lease number, OCS-A 0517, for that portion. Deepwater Wind South Fork, LLC changed its name to South Fork Wind, LLC. The remaining portion of Lease OCS-A 0486 was assigned to DWW Rev I, LLC. DWW Rev I, LLC changed its name to Revolution Wind, LLC (Revolution Wind).

Revolution Wind's goal is to develop a commercial-scale offshore wind energy facility in the Lease Area with WTGs; a network of IACs; up to two OSSs (OSS1 and OSS2); up to two export cables making landfall in North Kingstown, Rhode Island; one OnSS; and one ICF (see Figure 1.1-1). The Project, as described in Section 2.1.2, is the Proposed Action considered by BOEM in this Final EIS. The need for the Project is to contribute to Connecticut's mandate of 2,000 megawatts (MW) of offshore wind energy by 2030, as outlined in Connecticut Public Act 19-71, and to Rhode Island's 100% renewable energy goal by 2030, as outlined in Rhode Island Governor's EO 20-01 of January 2020. The Project would have the capacity to deliver up to 880 MW of power to the New England energy grid, satisfying the current power purchase agreement (PPA) total of 704 MW. Specifically, Revolution Wind's goal to construct and operate a commercial-scale offshore wind energy facility in the Lease Area is intended to fulfill the following three PPAs: a 200-MW contract with the State of Connecticut approved in January 2019, a 400-MW contract with the State of Rhode Island approved in June 2019, and a 104-MW contract with the State of Connecticut approved in December 2019.

Based on BOEM's authority under the Outer Continental Shelf Lands Act (OCSLA) to authorize renewable energy activities on the OCS, and Executive Order 14008; the shared goals of the federal agencies to deploy 30 GW of offshore wind energy capacity in the United States by 2030, while protecting biodiversity and promoting ocean co-use (The White House 2021); and in consideration of the goals of the applicant, the purpose of BOEM's action is to determine whether to approve, approve with modifications, or disapprove Revolution Wind's COP. BOEM will make this determination after weighing the factors in subsection 8(p)(4) of the OCSLA that are applicable to plan decisions and in consideration of the above goals. BOEM's action is needed to fulfill its duties under the Lease, which require BOEM to make a decision on the lessee's (Revolution Wind's) plans to construct and operate a commercial-scale offshore wind energy facility within the Lease Area (the Proposed Action).

The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) received a request for authorization to take marine mammals incidental to construction activities related to the Project, which NMFS may authorize under the Marine Mammal Protection Act (MMPA). NMFS's issuance of an MMPA incidental take authorization in the form of a Letter of Authorization (LOA) for Incidental Take Regulations (ITRs) is a major federal action and, in relation to BOEM's action, is considered a connected action (40 CFR 1501.9(e)(1)). The purpose of the NMFS action—which is a direct outcome of Revolution Wind's request for authorization to take marine mammals incidental to specified activities associated with the Project (e.g., pile driving)—is to evaluate Revolution Wind's request under requirements of the MMPA (16 USC 1371(a)(5)(A)) and its implementing regulations administered by NMFS and to decide whether to issue the authorization. NMFS needs to render a decision regarding the request for authorization due to NMFS's responsibilities under the MMPA (16 United States Code [USC] 1371(a)(5)(A and D)) and its implementing regulations. If NMFS makes the findings necessary to issue the requested authorization, NMFS intends to adopt, after independent review, BOEM's EIS to support that decision and fulfill its NEPA requirements. The U.S. Army Corps of Engineers (USACE) New England District anticipates requests for authorization of a permit action to be undertaken through authority delegated to the District Engineer by 33 CFR 325.8, pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) and Section 404 of the Clean Water Act (33 USC 1344). The USACE considers issuance of a permit under these two delegated authorities a major federal action connected to BOEM's Proposed Action (40 CFR 1501.9(e)(1)). The applicant's stated purpose and need for the Project, as indicated above, is to provide a commercially viable offshore wind energy project within Lease OCS-A 0486 to meet New England's need for clean energy. The USACE's basic Project purpose, as determined by the USACE for Section 404(b)(1) guidelines evaluation, is offshore wind energy generation. The USACE'S overall Project purpose for Section 404(b)(1) guidelines evaluation, as determined by the USACE, is the construction and operation of a commercial-scale offshore wind energy project, including associated transmission lines, for renewable energy generation and distribution to the Connecticut and Rhode Island energy grids. The USACE intends to adopt BOEM's EIS to support its decision on any permits requested under Section 10 of the Rivers and Harbors Act or Section 404 of the CWA.

1.3 Regulatory Framework

The provisions of the Energy Policy Act of 2005 implemented by BOEM, on behalf of the DOI, provide a framework for issuing renewable energy leases, easements, and rights-of-way (ROWs) for OCS activities. Section 8(p)(1)(C) of the OCSLA authorizes the Secretary to issue leases, easements, and ROWs on the OCS for wind energy development (43 USC 1337(p)(1)(C)). Section 8(p)(4) (43 USC 1337(p)(4)) of the OCSLA specifies requirements applicable to any activity carried out under Section 8(p). These requirements include, for example, that the Secretary shall

> ensure that any activity under this subsection [8(p)] is carried out in a manner that provides for . . . prevention of interference with reasonable uses (as determined by the Secretary) of the exclusive economic zone, the high seas, and the territorial seas . . . [and] consideration of . . . any other use of the sea or seabed, including use for a fishery, a sealane, a potential site of a deepwater port, or navigation. (Section 8(p)(4)(I) and (J)).

Final regulations implementing the authority for renewable energy leasing under the OCSLA (30 CFR 585) were promulgated on April 22, 2009 (Minerals Management Service [MMS] 2009). These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove the proposed COP (30 CFR 585.628). Several provisions under 30 CFR 585 are applicable to a decision on a COP, including 30 CFR 585.102 and Subpart F (Plans and Information Requirements). Specifically, 30 CFR 585.102 provides in part that

> BOEM will ensure that any activities authorized in this part are carried out in a manner that provides for . . . [p]rotection of the rights of other authorized users of the OCS; . . . [and] [p]revention of interference with reasonable uses (as determined by the Secretary or Director) of the exclusive economic zone, the high seas, and the territorial seas (30 CFR 585.102(a)(7) and (a)(9)).

In addition, 30 CFR 585.621 provides that a

> COP must demonstrate that [the lessee has] planned and [is] prepared to conduct the proposed activities in a manner that conforms to your responsibilities listed in §585.105(a) and:
>
> (a) conforms to all applicable laws, implementing regulations, lease provisions, and stipulations or conditions of your commercial lease;
>
> (b) is safe;
>
> (c) does not unreasonably interfere with other uses of the OCS, including those involved with national security or defense;
>
> (d) does not cause undue harm or damage to natural resources; life (including human and wildlife); property; the marine, coastal, or human environment; or sites, structures, or objects of historical or archaeological significance;
>
> (e) uses best available and safest technology;
>
> (f) uses best management practices (BMPs); and
>
> (g) uses properly trained personnel.

Consistent with the requirements of the OCSLA and applicable regulations, Section 2 of the Lease provides the lessee with an exclusive right to submit a COP to BOEM for approval. Section 3 of the Lease provides that BOEM will decide whether to approve a COP in accordance with applicable regulations in 30 CFR 585; noting that BOEM retains the right to disapprove a COP based on its determination that the proposed activities would have unacceptable environmental consequences, would conflict with one or more of the requirements set forth in 43 USC 1337(p)(4), or for other reasons provided by BOEM pursuant to 30 CFR 585.613(e)(2) or 585.628(f); that BOEM reserves the right to approve a COP with modifications; and that BOEM reserves the right to authorize other uses within the Lease Area and Project easement that will not unreasonably interfere with activities described in an approved COP pursuant to the Lease. Section 7 of the Lease provides that

> no activities authorized [under it] will be carried out in a manner that: (a) could unreasonably interfere with or endanger activities or operations carried out under any lease or grant issued or maintained pursuant to the Act, or under any other license or approval from any Federal agency; (b) could cause any undue harm or damage to the environment; (c) could create hazardous or unsafe conditions; or (d) could adversely

affect sites, structures, or objects of historical, cultural, or archaeological significance, without notice to and direction from the Lessor on how to proceed. (BOEM 2013b)

Addendum C of the Lease (BOEM 2013b) provides additional lease-specific terms, conditions, and stipulations that BOEM must consider when reviewing a COP.

1.4 Relevant Existing NEPA and Consulting Documents

BOEM developed the NEPA documents in Table 1.4-1 to inform the issues evaluated in this EIS.

Table 1.4-1. National Environmental Policy Act Documents Used to Inform the Evaluated Environmental Impact Statement Issues

Document	Description
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 (OCS EIS/EA MMS 2007-046) (MMS 2007).	This EIS examines the potential environmental consequences of implementing the Renewable Energy Program and establishes initial measures to mitigate environmental consequences. As the program evolves and more is learned, the mitigation measures are modified, or new measures developed for each project, subject to environmental reviews under NEPA and other statutes.
Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts, Revised Environmental Assessment (OCS EIS/EA BOEM 2013-1131) (BOEM 2013c).	This EA analyzes the reasonably foreseeable consequences associated with two distinct BOEM actions in the RI/MA WEA: 1) lease issuance (including reasonably foreseeable consequences associated with shallow hazards, geological, geotechnical, and archaeological resource surveys); and 2) site assessment plan approval (including reasonably foreseeable consequences associated with the installation and operation of meteorological towers and meteorological buoys). Based on the analysis in the EA, BOEM developed several standard operating conditions to reduce or eliminate the potential environmental risks to or conflicts with individual environmental and socioeconomic resources.
National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf, May 2019 (OCS Study 2019- 036) (BOEM 2019).	This study identifies the relationships between IPFs associated with specific past, present, and reasonably foreseeable actions and activities in the North Atlantic OCS, which were incorporated into this EIS analysis. If an IPF was not associated with the RWF Project, it was not included in the impacts analysis of planned activities.

BOEM has elected to incorporate by reference the RWF COP prepared by VHB for Revolution Wind dated March 1, 2023. The COP and its supporting documentation provide a description of the proposed Project activity, Project siting and design development, resources required, site characterization and assessment of potential impacts, and references. The RWF COP is located on the BOEM webpage for the RWF Project at this link: https://www.boem.gov/renewable-energy/state-activities/revolution-wind.

Additional environmental studies conducted to support planning for offshore wind energy development are cited throughout the EIS where applicable, and are available on BOEM's website: https://www.boem.gov/renewable-energy-research-completed-studies.

1.5 Methodology for Assessing the Project Design Envelope

Revolution Wind proposes using a project design envelope (PDE) concept, consistent with BOEM's *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan* (BOEM 2018). This concept allows Revolution 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 OSSs.

This EIS assesses the impacts of the PDE that is described in the Revolution Wind COP and presented in Appendix D (Project Design Envelope and Maximum-Case Scenario) by using the "maximum-case scenario" process. Through the maximum-case scenario process, BOEM analyzes the aspects of each design parameter or combination of parameters that would result in the greatest impact for each physical, biological, and socioeconomic resource. Through consultation with its own engineers and outside industry experts, BOEM verified that the maximum-case scenario analyzed in the EIS could reasonably occur.

1.6 Methodology for Assessing Impacts from Past, Present, and Planned Actions

This EIS assesses past, present (ongoing), and reasonably foreseeable future (planned) actions that could occur during the life of the Project. Ongoing and planned actions occurring within the geographic analysis areas (GAAs) include 1) other offshore wind energy development activities; 2) undersea transmission lines, gas pipelines, and other submarine cables (e.g., telecommunications); 3) tidal energy projects; 4) marine minerals use and ocean-dredged material disposal; 5) military use; 6) marine transportation (commercial, recreational, and research-related); 7) fisheries use, management, and monitoring surveys; 8) global climate change; 9) oil and gas activities; and 10) onshore development activities. Appendix E (Planned Activities Scenario and Reasonably Foreseeable Future Activities and Projects) describes the past and ongoing actions that BOEM has identified as potentially contributing to the existing condition, and the planned actions potentially contributing to cumulative impacts when combined with impacts from the alternatives over the specified spatial and temporal scales.

In 2019, BOEM released a study of IPFs from renewable energy projects on the North Atlantic OCS (BOEM 2019). As noted, in addition to the general planned action analysis associated with onshore and offshore non-wind activities, this EIS specifically discloses the impacts from planned actions of relevant IPFs from offshore wind by resource (Appendix E1 [Description and Screening of Relevant Offshore Wind and Non–Offshore Wind Impact Producing Factors and Negligible Impact Determinations]). Where possible, BOEM quantitatively estimates these offshore wind impacts. However, readers of the EIS should not consider these results as absolute values or predictions of actual future conditions. Although BOEM estimates represent the best tool currently available to inform the impact analysis in the EIS, it is not possible to precisely predict future conditions. Estimates are based on past experience and trends and represent reasonable assumptions about future behaviors.

1.6.1 Past and Ongoing Activities and Trends (No Action Alternative)

Each resource-specific Environmental Consequences section for the No Action Alternative in Chapter 3 of this EIS discloses past and present activities in the GAA, including those related to offshore wind projects with an approved COP (e.g., Vineyard Wind 1 and South Fork Wind Farm [SFWF]), approved past and ongoing site assessment surveys, and other non-wind activities (e.g., Navy military training, existing vessel traffic, climate change). This disclosure of past and present activities in the GAA is the existing condition of the affected environment. Other factors currently impacting the resource, including climate change, are also acknowledged for that resource and are included in the impact-level conclusion.

1.6.2 Planned Activities

It is reasonable to predict that future activities may occur over time, and that cumulatively, those activities would impact the affected environment. Future planned activities are disclosed in Appendix E. Cumulative impacts based on future planned activities are analyzed and concluded separately in each resource-specific Environmental Consequences section in Chapter 3 of this EIS. The impacts of future planned offshore wind projects are predicted using information from, and assumptions based on, COPs submitted to BOEM that are currently undergoing independent review.

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2 Alternatives Including the Proposed Action

2.1 Alternatives

Sections 2.1.1 through 2.1.7 of this chapter describe six action alternatives and a no action alternative for the Project, which are summarized in Table 2.1-1. Section 2.1.8 addresses alternatives not carried forward for analysis, Section 2.2 addresses non-routine activities and low-probability events associated with the Project, and Section 2.3 provides a summary and comparison of impacts by alternative (see Table 2.3-1). More detailed comparisons of impacts by environmental resource and alternative, to include incremental impacts between alternatives, are provided in Chapter 3.

These alternatives were developed using BOEM's screening criteria for determining a range of reasonable alternatives, extensive coordination with cooperating and participating agencies (federal, state, local, and tribal agencies), and input from the public and potentially affected stakeholders throughout the scoping process (BOEM 2022a). The alternatives described below are not mutually exclusive. If the COP is approved or approved with modifications, BOEM could "mix and match" multiple listed alternatives or components thereof to result in a preferred alternative so long as crucial design parameters are compatible and otherwise meet the purpose of and need for the Proposed Action.

After carefully considering the EIS alternatives and input from the public, cooperating agencies, and Project proponent, BOEM has identified Alternative G as the Preferred Alternative, as described in Section 2.1.7. A preferred alternative informs the public of which alternative BOEM, as the lead agency, is leaning toward before an alternative is selected in a ROD. No final agency action is being taken by the identification of the Preferred Alternative, and BOEM is not obligated to select the Preferred Alternative. Appendix K (Supplemental Information on Alternatives Development) has more detail for the development of all alternatives and feasibility considerations, including the Preferred Alternative.

Table 2.1-1. Alternative Descriptions

Alternative	Description
A: No Action Alternative	Under the No Action Alternative, BOEM would not approve the COP. Project construction and installation, O&M, and decommissioning would not occur, and no additional permits or authorizations for the Project would be required. Any potential environmental and socioeconomic impacts, including benefits, associated with the Project as described under the Proposed Action or the Preferred Alternative, would not occur. However, all other past and ongoing impact-producing activities, including approved offshore wind projects (SFWF and Vineyard Wind), would continue. Under the No Action Alternative, impacts to marine mammals incidental to construction activities would not occur. Therefore, NMFS would not issue the requested authorization under the MMPA to the applicant. The current resource condition, trends, and impacts from ongoing activities under the No Action Alternative serve as the baseline against which the direct and indirect impacts of all action alternatives are evaluated. Over the life of the Project, other reasonably foreseeable future impact-producing offshore wind and non–offshore wind activities would be implemented, which would cause changes to the affected environment even in the absence of the Proposed Action or the Preferred Alternative. The continuation of all other existing and reasonably foreseeable future activities described in Appendix E without the Proposed Action or the Preferred Alternative serves as the baseline against which the cumulative impacts of all alternatives are evaluated.
B: Proposed Action Alternative (Proposed Action)	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable environmental protection measures (EPMs), as described in the COP. The Proposed Action would include up to 100 WTGs ranging in nameplate capacity of 8 to 12 MW sufficient to fulfill at a minimum the existing PPAs (total of 704 MW) up to 880 MW, the maximum capacity identified in the PDE. The WTGs would be connected by a network of IACs; up to two OSSs[4] connected by one OSS-link cable; up to two submarine export cables co-located within a single corridor; up to two underground transmission circuits located onshore; one onshore ICF; and one OnSS inclusive of up to two interconnection circuits connecting to the existing Davisville Substation in North Kingstown, Rhode Island. The Proposed Action includes the burial of offshore export cables below the seafloor in both the OCS and Rhode Island state waters and a uniform east-west and north-south grid of 1 × 1–nm spacing between WTGs.[5]
C: Habitat Impact Minimization Alternative	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the COP. To reduce impacts to complex fisheries habitats most vulnerable to permanent and long-term impacts from the Proposed Action, however, certain WTG positions would be eliminated while maintaining a uniform east-west and north-south grid of 1 × 1–nm spacing between WTGs. The placement of WTGs would be supported by location-specific benthic and habitat characterizations conducted in close coordination with NMFS. Under

[4] Each OSS has a maximum nominal capacity of 440 MW; therefore, two OSSs are required to achieve the PPA obligations of 704 MW.

[5] In accordance with 30 CFR 585.634(C)(6), micrositing of WTG foundations may occur within 500 feet from each proposed WTG location. WTG micrositing would be performed on a case-by-case basis to avoid significant seafloor hazards such as surface and subsurface boulders (see COP Section 2.2.1.1).

Alternative	Description
	Alternative C, fewer WTG locations (and potentially fewer miles of IACs) than the Proposed Action would be approved by BOEM. Under this alternative, there would be five “spare” WTGs: • Alternative C1: This alternative allows for the fulfillment of the existing three PPAs, which total 704 MW, while omitting WTGs in locations to maintain a uniform east-west and north-south grid of 1 × 1–nm spacing between WTGs. Under this alternative, up to 35 WTGs and associated IACs would be removed from consideration, resulting in up to 65 WTGs and associated IACs being approved. • Alternative C2: This alternative allows for the fulfillment of the existing three PPAs, which total 704 MW, while omitting WTGs in locations to maintain a uniform east-west and north-south grid of 1 × 1–nm spacing between WTGs. Under this alternative, up to 36 WTGs and associated IACs would be removed from consideration, resulting in up to 64 WTGs and associated IACs being approved. Refer to Appendix K for background information on the development of the Alternative C1 and C2 layouts.
D: No Surface Occupancy in One or More Outermost Portions of the Project Area Alternative	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the COP. However, to reduce conflicts with other competing space-use vessels, WTGs adjacent to or overlapping transit lanes proposed by stakeholders or the Buzzard’s Bay Traffic Separation Scheme Inbound Lane would be eliminated while maintaining the uniform east-west and north-south 1 × 1–nm grid spacing between WTGs. Under Alternative D, BOEM could select one, all, or a combination of the following three alternatives, while still allowing for the fulfillment of existing PPAs and up to the maximum capacity identified in the PDE (i.e., 880 MW). Under this alternative, fewer WTG locations (and potentially fewer miles of IACs) than the Proposed Action would be approved by BOEM. Under this alternative, there would be up to six “spare” WTGs: • Alternative D1: Removal of the southernmost row of WTGs that overlap the 4-nm east-west transit lane proposed by the Responsible Offshore Development Alliance (RODA), as well as portions of Cox Ledge. Under this alternative, up to seven WTGs and associated IACs would be removed from consideration, resulting in up to 93 WTGs and associated IACs being approved. • Alternative D2: Removal of the eight easternmost WTGs that overlap the 4-nm north-south transit lane proposed by RODA. Under this alternative, up to eight WTGs and associated IACs would be removed from consideration, resulting in up to 92 WTGs and associated IACs being approved. • Alternative D3: Removal of the northwest row of WTGs adjacent to the Inbound Buzzards Bay Traffic Lane. Under this alternative, up to seven WTGs and associated IACs would be removed from consideration, resulting in up to 93 WTGs and associated IACs being approved. The selection of all three alternatives (i.e., D1, D2, and D3) would eliminate up to 22 WTG locations and associated IACs, resulting in up to 78 WTGs and associated IACs being approved while maintaining the 1 × 1–nm grid spacing proposed in the COP and as described in Alternative B. Based on the design parameters outlined in the COP, allowing for the placement of 78 to 93

Alternative	Description
	WTGs and two OSSs would still allow for the fulfillment of up to the maximum capacity identified in the PDE (e.g., 880 MW = 74 WTGs needed if 12-MW WTGs are used).
E: Reduction of Surface Occupancy to Reduce Impacts to Culturally-Significant Resources Alternative	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the COP. However, to reduce the visual impacts on culturally important resources on Martha's Vineyard and in Rhode Island, some WTG positions would be eliminated while maintaining the uniform east–west and north–south 1 × 1–nm grid spacing between WTGs. Under Alternative E, fewer WTG locations (and potentially fewer miles of IACs) than the Proposed Action would be approved by BOEM. Under this alternative, there would be up to five "spare" WTGs: • Alternative E1: Allows for the fulfillment of the existing three PPAs totaling 704 MW, while eliminating WTG locations to reduce visual impacts on these culturally-important resources. Under this alternative, up to 36 WTGs and associated IACs would be removed from consideration, resulting in up to 64 WTGs and associated IACs being approved. • Alternative E2: Allows for a power output delivery identified in the PDE of up to 880 MW while eliminating WTG locations to reduce visual impacts on these culturally-important resources. Under this alternative, up to 19 WTGs and associated IACs would be removed from consideration, resulting in up to 81 WTGs and associated IACs being approved. Refer to Appendix K for background information on the development of the Alternative E1 and E2 layouts.
F: Selection of a Higher Capacity Wind Turbine Generator	The construction and installation, O&M, and eventual decommissioning of a wind energy facility implementing a higher nameplate capacity WTG (up to 14 MW) than what is proposed in the COP. This higher capacity WTG must fall within the physical design parameters of the PDE and be commercially available to the Project proponent within the time frame for the construction and installation schedule proposed in the COP. The number of WTG locations under Alternative F would be sufficient to fulfill the minimum existing PPAs (total of 704 MW and 56 WTGs, including up to five "spare" WTG locations). Using a higher capacity WTG would potentially reduce the number of foundations constructed to meet the purpose and need and thereby potentially reduce impacts to marine habitats and culturally significant resources and potentially reduce navigation risks.
G: Preferred Alternative	The construction and installation, O&M, and eventual decommissioning of a wind energy facility within the range of the design parameters outlined in the COP, subject to applicable mitigation measures. Alternative G (the Preferred Alternative) was designed to reduce impacts to visual resources and benthic habitat. This alternative would include up to 79 possible positions for the installation of 65 WTGs, which would range in nameplate capacity of 8 to 12 MW sufficient to fulfill at a minimum the existing PPAs (total of 704 MW) while maintaining the uniform east-west and north-south 1 × 1–nm grid spacing between WTGs. Under this alternative, there would be up to 14 "spare" WTG positions available for use if unforeseen siting conditions occur necessitating relocation of any of the 65 WTGs from the possible positions. Two of the 65 WTGs could be located in three different spots within the 79 WTG possible positions. As a result, Alternative G includes the analysis of three alternatives for installation of the 65 WTGs, Alternatives G1–G3. This flexibility in design could allow for further refinement for visual resources impact reduction on Martha's Vineyard and Rhode Island, or for habitat impact reduction in the NMFS Priority 1 area.

Alternative	Description
	• Alternative G1: Allows for the fulfillment of the existing three PPAs totaling 704 MW, while relocating two WTG locations from a NMFS Priority 1 area to reduce fishery and EFH impacts. Under this alternative, 35 WTGs and associated IACs would be removed from consideration, resulting in 65 WTGs and associated IACs being installed in the positions identified under this alternative. • Alternative G2: Allows for the fulfillment of the existing three PPAs totaling 704 MW, while relocating two WTG locations to reduce visual impacts on the horizon from the Aquinnah Overlook, a culturally important resource. Under this alternative, 35 WTGs and associated IACs would be removed from consideration, resulting in 65 WTGs and associated IACs being installed in the positions identified under this alternative. • Alternative G3: Allows for the fulfillment of the existing three PPAs totaling 704 MW, while relocating two WTG locations closest to the shore of Martha's Vineyard to reduce visual impacts to this culturally important resource. Under this alternative, 35 WTGs and associated IACs would be removed from consideration, resulting in 65 WTGs and associated IACs being installed in the positions identified under this alternative. All other components of Alternative G are the same as the Proposed Action: two OSSs connected by an OSS-link cable; up to two submarine export cables co-located within a single corridor; up to two underground transmission circuits located onshore within a single corridor; and an onshore substation inclusive of up to two interconnection circuits within a single corridor connecting to the existing Davisville Substation in North Kingstown, Rhode Island. Refer to Appendix K for background information on the development of the Alternative G and Alternative G1, G2 and G3.

2.1.1 Alternative A: No Action Alternative

Under Alternative A, hereafter referred to as the No Action Alternative, BOEM would not approve the RWF COP, and the Project construction and installation, O&M, and decommissioning would not occur.[6] Likewise, no additional permits or authorizations would be required. Any potential environmental and socioeconomic impacts, including beneficial impacts, associated with the Project, as described under the Proposed Action, would not occur. However, all other past and ongoing impact-producing activities would continue. Under the No Action Alternative, NMFS would not issue the requested authorization under the MMPA, and therefore impacts to marine mammals incidental to Project activities would not occur. The current resource condition, trends, and impacts from ongoing activities under the No Action Alternative serve as the existing condition against which the direct and indirect impacts of all action alternatives are evaluated.

The continuation of all other existing and reasonably foreseeable future activities described in Appendix E, without the Proposed Action, serves as the future condition against which the cumulative impacts of the action alternatives are evaluated.

2.1.2 Alternative B: Proposed Action Alternative

Alternative B, hereafter referred to as the Proposed Action, would comprise the construction and installation, O&M, and eventual decommissioning of the Project, as described in the COP and in Table 2.1-1.

The RWF and RWEC are the two primary components of the Project (Figures 2.1-1 and 2.1-2). The RWF consists of WTGs, up to two OSSs (OSS1 and OSS2), a network of IACs, and one OSS-link cable (see Table 2.1-1). The RWEC would comprise offshore segments and onshore segments. The RWEC offshore segment would include up to two submarine export cables co-located within a single corridor up to 42 miles in length (up to 19 miles of which would be in federal waters and 23 miles of which would be in state waters). The RWEC onshore segment consists of the landfall work area, where the offshore and onshore cables are joined; the onshore transmission cable; the OnSS; and the ICF. The onshore elements of the Proposed Action are included in BOEM’s analysis in the EIS to support analysis of a complete Project; however, BOEM’s authority under the OCSLA only extends to the activities on the OCS.

2.1.2.1 Revolution Wind Farm Components

As presented in Table 2.1-2, the RWF components and their construction and operation footprints include up to 100 WTGs, up to two OSSs (OSS1 and OSS2), a network of IACs, and one OSS-link cable. The PDE allows for a range of WTGs between 8 and 12 MW in capacity. Additional information on WTG and OSS layout within the Lease Area is provided in Appendix D, Table D-2 and Figure D-1.

[6] Under the No Action Alternative, NMFS would not issue the requested authorization under the MMPA to the applicant. NMFS’s action alternative is to issue the requested Incidental Take Regulation (ITR) and subsequent Letter of Authorization (LOA) to the applicant to authorize incidental take for the activities specified in its application and that are being analyzed by BOEM in the reasonable range of alternatives described here.

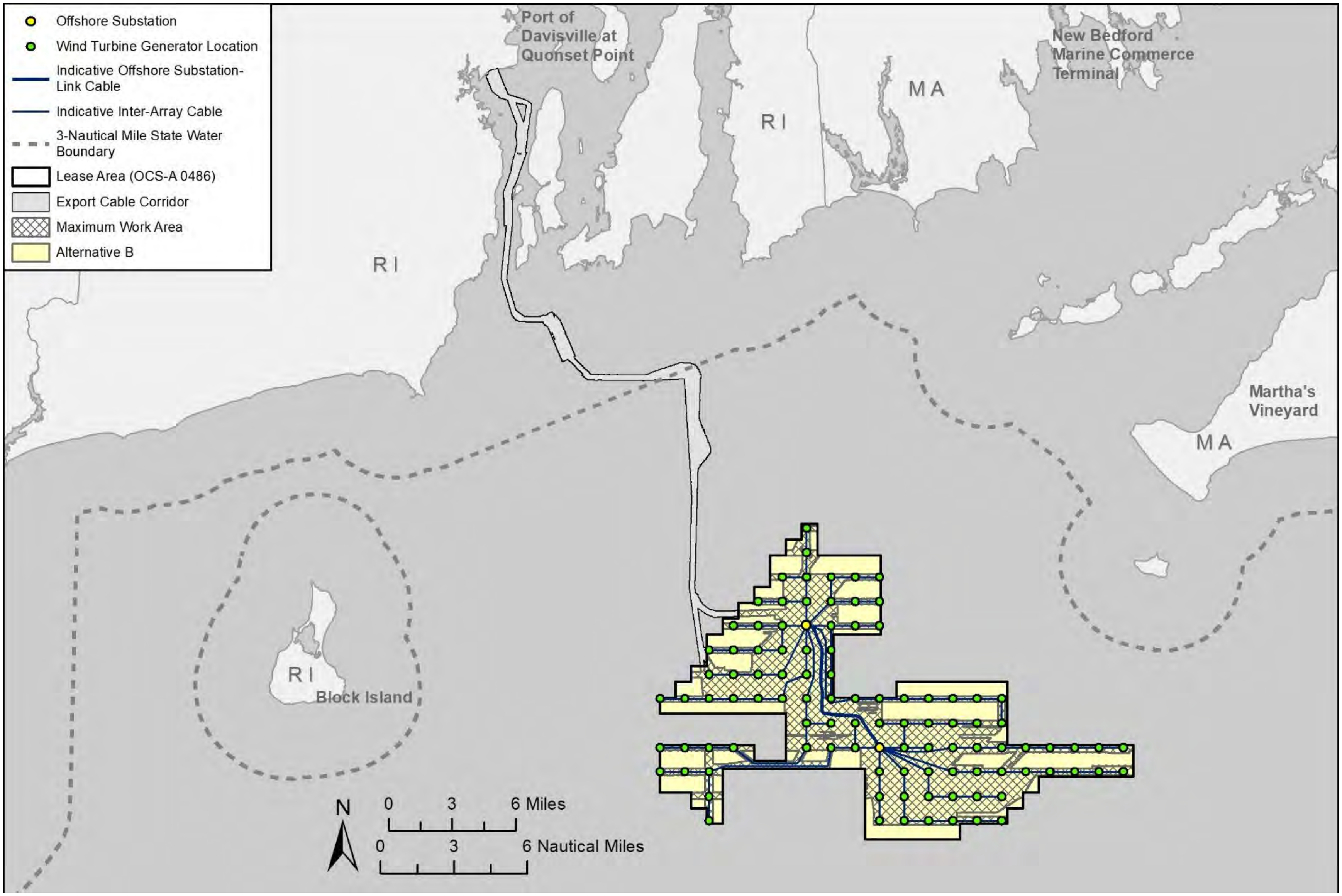


Figure 2.1-1. Offshore Project location and components under the Proposed Action (Alternative B).

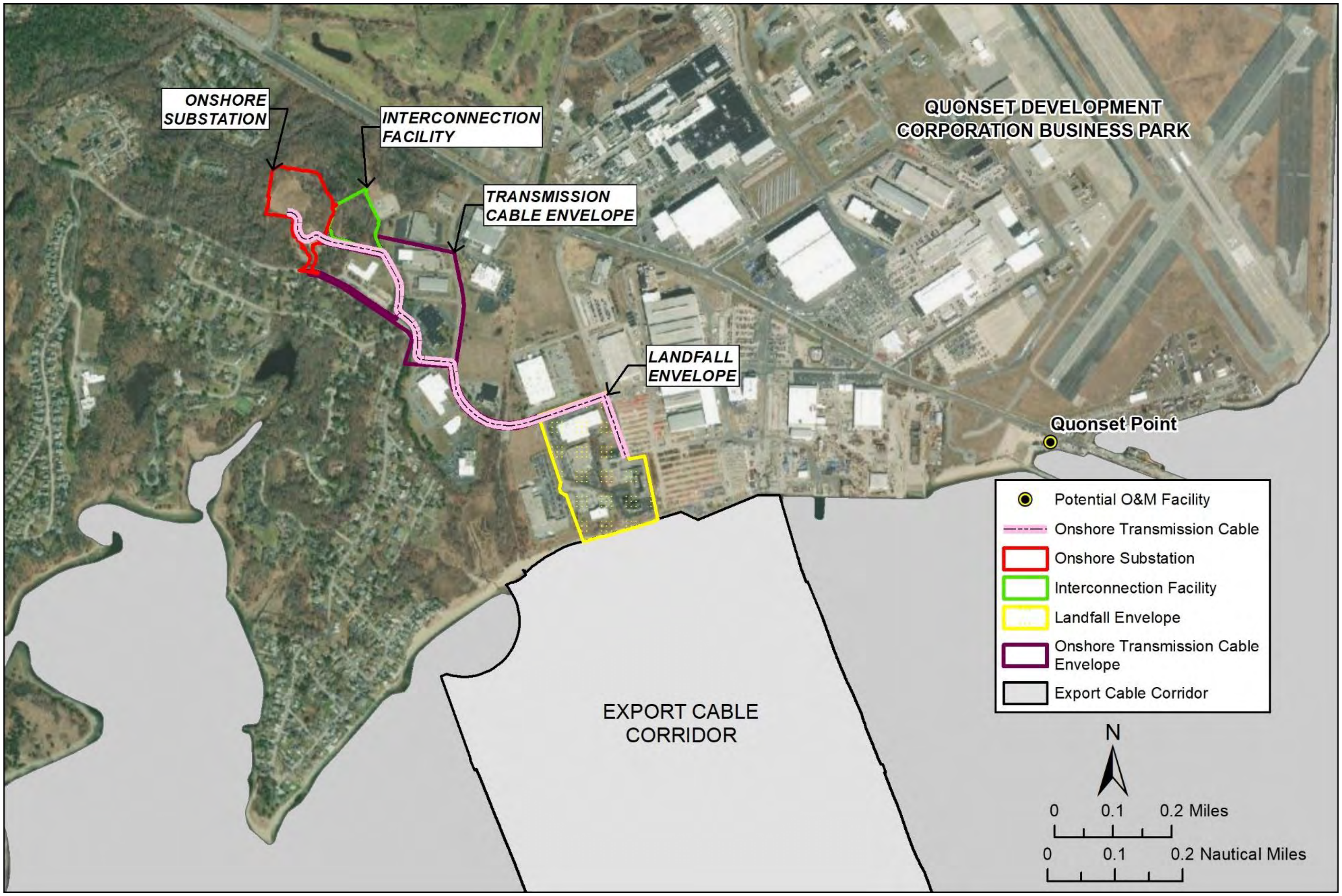


Figure 2.1-2. Onshore Project location and components under the Proposed Action (Alternative B).

Table 2.1-2. Revolution Wind Farm Components and Footprint under the Proposed Action (Alternative B)

Project Component	Location	Project Envelope Characteristics	Construction and Installation Footprint	Operation Footprint
WTGs WTG monopile foundation WTG monopile scour protection	Offshore in the OCS	WTGs: Up to 100 WTGs with a nameplate capacity of 8 to 12 MW, rotor diameter of 538 to 722 feet, hub height of 377 to 512 feet above mean sea level (amsl), and upper blade tip height up to 873 feet amsl WTG monopile foundation: A diameter of 20 to 39 feet and a target burial depth of 98 to 164 feet WTG monopile scour protection: Rock placement, mattress protection, sandbags, and/or stone bags placed prior to foundation installation*	WTG monopile foundation: 31.1 acres x 100 WTG = 3,110 acres Jack-up disturbance per WTG installation: 0.18 acre x 100 WTG x 1.15 = 20.7 acres¶ Total WTG disturbance: 3,131 acres	WTG monopile foundation: 0.027 acre x 100 WTG = 2.7 acres WTG monopile scour protection: 0.67 acre x 100 WTG = 67 acres Cable protection system stabilization for WTG and OSS (102) foundations combined: 7.1 acres
OSS OSS monopile foundation OSS monopile scour protection	Offshore in the OCS	OSS: Up to two OSSs (OSS1 and OSS2) and up to 262 feet amsl (with lightning protection) OSS monopile foundation: A diameter of 20 to 49 feet and a maximum embedment depth of 164 feet OSS monopile scour protection: Rock placement, mattress protection, sandbags, and/or stone bags placed prior to foundation installation*	OSS monopile foundation: 31.1 acres x 2 OSS = 62.2 acres Jack-up disturbance per OSS installation: 0.18 acre x 2 OSS = 0.36 acre Total OSS disturbance: 62.6 acres	OSS monopile foundation: 0.043 acre x 2 OSS = 0.086 acre OSS monopile scour protection: 0.66 acre x 2 OSS = 1.3 acres
IAC IAC protection	Offshore in the OCS	IAC: Up to a 155-mile total length with a 72-kilovolt (kV) AC cable with a diameter of 8 inches connecting WTGs and OSSs	IAC: 2,471 acres	IAC protection: 74.1 acres§

Project Component	Location	Project Envelope Characteristics	Construction and Installation Footprint	Operation Footprint
		IAC protection: Rock berms, concrete mattresses, fronded mattresses, and/or rock bags constituting up to 10% of the route for each cable		
OSS-link cable† OSS-link cable protection	Offshore in the OCS	OSS-link cable: Up to a 9-mile-long 275-kV high-voltage AC OSS-link cable with a diameter of 11.8 inches connecting OSS1 and OSS2 OSS-link cable protection: Rock berms, concrete mattresses, fronded mattresses, and/or rock bags constituting up to 10% of route for each cable	148 acres	4.4 acres
Vessel anchoring and mooring	Offshore in the OCS, state waters, along the RWEC offshore route, and at the cable landfall	Vessels for cable laying may anchor within the 1,640-foot-wide Project easement. Anchors for cable laying vessels have a maximum penetration depth of 15 feet. Jack-up vessels for foundation and WTG installation would include up to four spudcans with a maximum penetration depth of 52 feet and would occur within the 656-foot radius around foundation locations.	Not provided Although the COP does not specify individual anchor locations, it indicates that vessel anchoring and mooring may occur at any location in the construction and installation footprint	N/A

Source: VHB (2023)

Note: COP Tables 1.2-1, 3.3.4-1, 3.3.4-2, 3.3.5-1, 3.3.6-1, 3.3.6-2, 3.3.7-1, 3.3.7-2, and 4.1.1-1 provide assumptions used to develop the footprint estimates.

* As described in COP Section 3.3.4.2, scour protection would be installed around foundations. Several types of scour protection may be considered, including rock placement, mattress protection, sandbags, and stone bags. However, rock placement is the most frequently used solution. The design typically includes a sloped outer edge that meets the natural grade of the seafloor to the extent practicable. Depending on the nature of the rock used, the size would vary, but the average diameter would be approximately 8 inches (20 centimeters [cm]). Scour protection depth at monopile foundations would be approximately 2.2 to 4.6 feet above the seafloor. Additional details for the engineering specifications for the rock required for use as scour protection at the RWF are provided in the COP. Any rock used for scour protection would meet these specifications. COP Appendix H, Supplemental Project Information and Conceptual Project Engineering Design Drawings (BOEM 2021a), also includes a conceptual drawing for cable/scour protection at foundations. Engineering specifications for rock, a naturally occurring material, are as follows:

- Rock class: LMA5/40
- Particle density: 165 pounds per cubic foot
- Armor stone rock class
- Rock material must have been produced from blasted rock faces and may not be sourced from riverbed mining/extraction or equivalent.
- Mudstone, shale, and slate rock or similar rock likely to cleave during handling are not acceptable.

- The armor stone may not in general be flaky or elongated.

† The OSS-link cable would have similar design and construction parameters as the RWEC (see Section 2.1.2.3.1).

‡ COP Section 3.3.10.2 states that seafloor impacts from general construction vessel anchoring may occur anywhere within the identified APE centered on cable routes. The total amount of seafloor disturbance due to vessel anchorage cannot be estimated but is considered a temporary impact and not to occur outside of the surveyed area.

§ The general disturbance corridor width for the IAC is 131 feet (40 meters). IAC protection is calculated by multiplying a portion (10%) of the cable route by the disturbance corridor.

¶ Revolution Wind assumes that 15% of the WTG foundations would need an additional jack-up.

2.1.2.1.1 Wind Turbine Generators

Each WTG would comprise the following major components: a tower, a nacelle (a cover housing the generator, gear box, drive train, and brake assembly), and a rotor that includes three blades. Figure 2.1-3 and Table 2.1-3 provide typical dimensions for different WTG size classes that fall within the PDE. Control, lighting, marking, and safety systems would be installed on each WTG.[7] The WTG lighting scheme is detailed in Figure 2.1-4. If needed, the WTGs could be powered by a permanent battery backup power solution with integrated energy harvest from the rotor or by a temporary diesel generator. The WTGs could be accessed from either the use of the Get Up Safe system, a motion-compensated hoist system allowing vessel-to-foundation personnel transfers without a boat landing), or a gangway launched from the service operations vessel (SOV) Edison Chouest Offshore (ECO Edison) (COP Section 3.3.4.1). Additional information on WTG layout within the Lease Area is provided in Appendix D, Table D-2 and Figure D-1.

[7] The WTGs would each be lit, individually marked, and maintained as private aids to navigation in accordance with the guidance provided in *Aids to Navigation Manual Administration* (U.S. Coast Guard [USCG] 2015) and would also comply with recommendations in *IALA Recommendation RO139 (O-139) The Marking of Man-Made Offshore Structures* (International Association of Marine Aids to Navigation and Lighthouse Authorities 2013) and recently proposed BOEM guidance on the marking and lighting of offshore wind farms (BOEM 2021b). Revolution Wind would also light and mark all WTGs in accordance with Federal Aviation Administration (FAA) Advisory Circular 70/7460-1L (FAA 2018), as recommended by BOEM (84 *Federal Register* 57471).

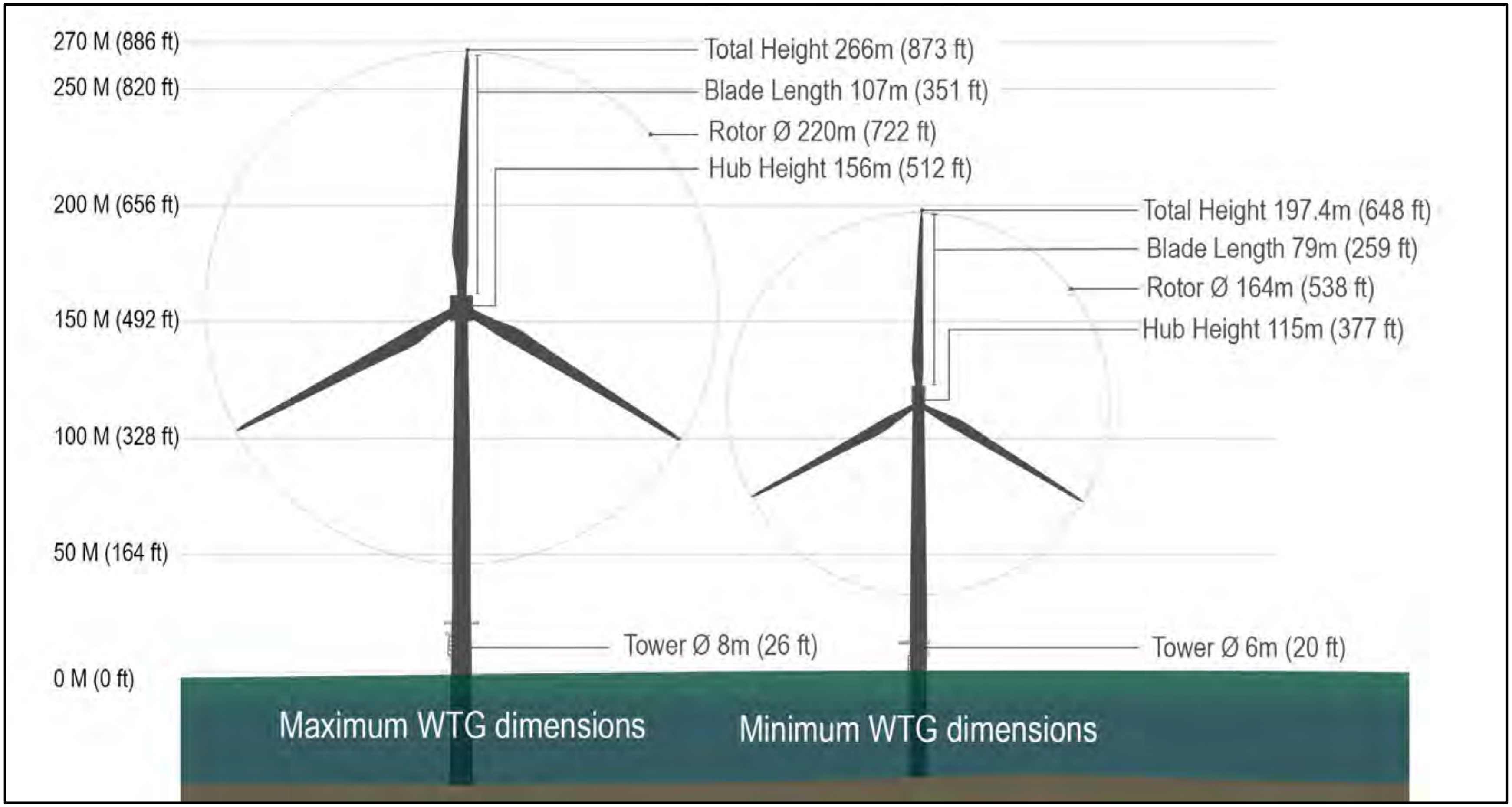


Figure 2.1-3. Wind turbine generator design envelope characteristics (VHB 2023:108).

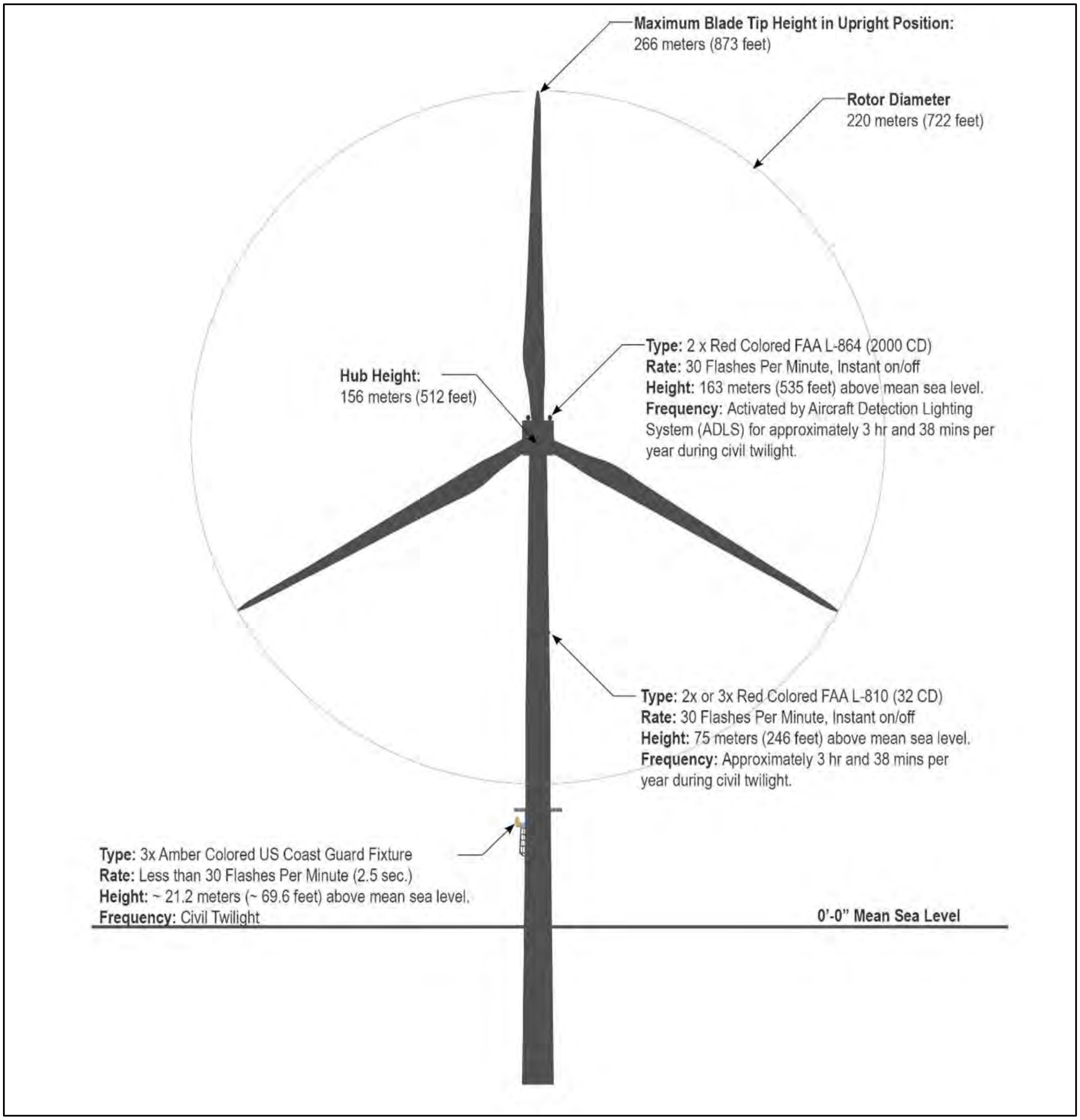


Figure 2.1-4. Wind turbine generator lighting scheme (Revolution Wind 2022).

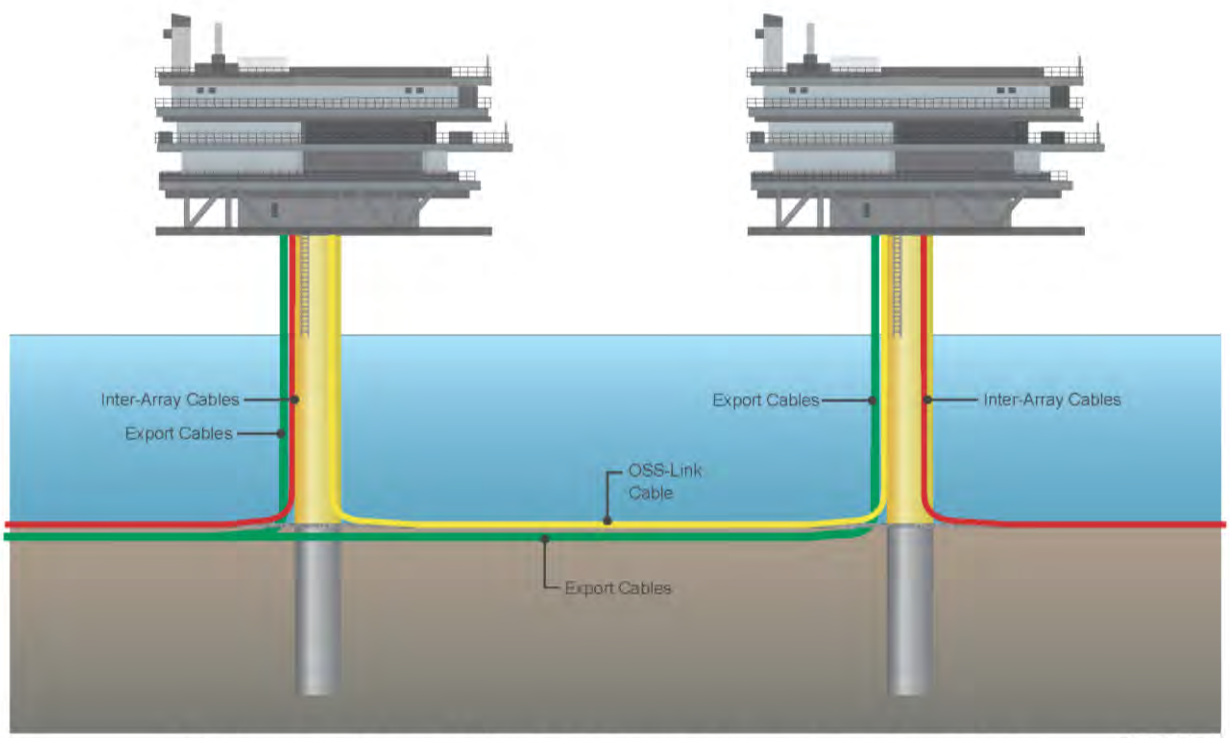
Table 2.1-3. Wind Turbine Generator Project Design Envelope Characteristics

WTG Characteristic	Minimum	Maximum
Hub height (from mean sea level)	377 feet	512 feet
Turbine height (from mean sea level)	646 feet	873 feet
Air gap (mean sea level to the bottom of the blade tip)	93.5 feet	151 feet
Base height (foundation height to top of transition piece)	82 feet	128 feet
Base (tower) width (at the bottom)	19.7 feet	26 feet
Base (tower) width (at the top)	13 feet	21 feet
Nacelle dimensions (length × width × height)	46 × 23 × 20 feet	72 × 33 × 39 feet
Blade length	259 feet	351 feet
Maximum blade width	16 feet	26 feet
Rotor diameter	538 feet	722 feet
Operation cut-in wind speed	7 to 11 miles per hour	
Operational cut-out wind speed	55 to 80 miles per hour	

Source: VHB (2023).

2.1.2.1.2 Offshore Substations

Up to two OSSs, each with a maximum nominal capacity of 440 MW, would be required to support the maximum design capacity (880 MW) of the Project. The OSS would be unmanned but could contain additional facilities such as breakrooms, locker facilities, and general storage for staff and equipment. The OSS would be installed on monopile foundations (Figure 2.1-5). The OSSs could be accessed from either the use of the Get Up Safe system or the use of a gangway launched from the SOV ECO Edison (Revolution Wind 2022). The OSS lighting scheme is detailed in Figure 2.1-6.



Distance shown between Offshore Substations is not representative of Project design

Note: Piled jacket foundations have been removed from the COP.

Figure 2.1-5. Indicative offshore substation co-location with associated cabling (VHB 2023:99).

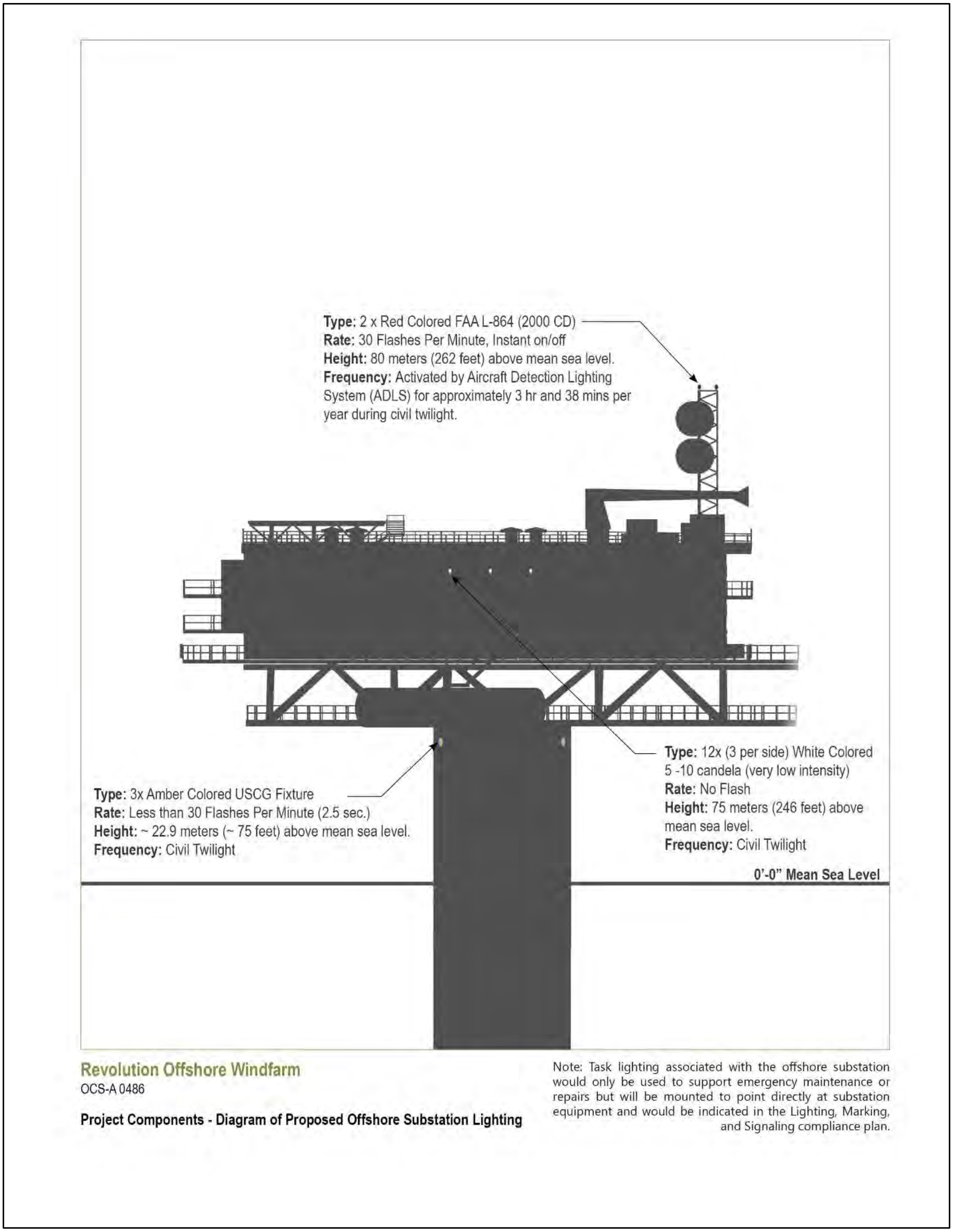


Figure 2.1-6. Offshore substation lighting scheme (Revolution Wind 2022).

2.1.2.1.3 Wind Turbine Generator Foundations and Offshore Substation Foundations

In the COP, monopile foundations are proposed as the preferred design option for WTGs and OSSs (COP Section 2.2.2.2). Monopile foundation types require tubular steel piles to be driven into the seafloor to a target depth of embedment (98–164 feet). Additional information on the foundation dimensions is provided in COP Tables 3.3.4-1, 3.3.4-2, and 4.1.1-1, and conceptual examples are depicted in COP Figure 2.2.2-1.

2.1.2.1.4 Wind Turbine Generator Scour Protection and Offshore Substation Foundation Scour Protection

Final engineering design at the facility design report/facility installation report stage could indicate that scour protection is necessary for the WTG and OSS foundations (see Table 2.1-2 and Section 2.1.2.1). Scour protection is designed to prevent foundation structures from being undermined by hydrodynamic and sedimentary processes, resulting in seafloor erosion and subsequent scour hole formation. Several types of scour protection could be considered, including rock placement, mattress protection, sandbags, and stone bags. Rock placement, which involves the use of large quantities of crushed rock placed around the base of the foundation structure, is most frequently used (VHB 2023). Depending on the nature of the rock used, the rock size would vary, but the average diameter would be approximately 8 inches. The footprint with scour protection would be a maximum of 0.7 acre for monopile foundations. Additional details for the engineering specifications and sourcing requirements for the rock use as scour protection for the Project are provided in COP Section 3.3.4.2.

2.1.2.1.5 Inter-Array Cables

A network of IACs would connect individual WTGs and would transfer power from the WTGs to the OSSs. The network of IACs would be 72-kV AC, 8 inches in diameter, and up to 155 miles in length. Each IAC would consist of three bundled copper or aluminum conductor cores surrounded by insulation and various protective armoring and sheathing to shield the cable from damage. A fiber-optic cable would also be included between the three conductors to transmit data from each of the WTGs to the SCADA system for continuous monitoring. The target burial depth for the IACs is 4 to 6 feet. The IACs would be installed within a 131-foot-wide corridor.

2.1.2.1.6 Offshore Substation-Link Cable

The two OSSs would be connected by one 275-kV high-voltage AC submarine transmission cable (OSS-link cable) up to 9 miles long. The maximum design scenario for the OSS-link cable and maximum seafloor disturbances are provided in Tables 2.1-4 and 2.1-5, respectively (also see COP Table 3.3.6-1 and Table 3.3.6-2).

Table 2.1-4. Offshore Substation-Link Cable Characteristics

OSS-Link Cable Characteristic	Maximum Design Scenario
Number of cables	1
Voltage	275 kV
Cable diameter	11.8 inches

OSS-Link Cable Characteristic	Maximum Design Scenario
Target burial depth (below seafloor)	4 to 6 feet*
Maximum disturbance depth	10 feet
Disturbance corridor (total width)†	Up to 131 feet

Source: VHB (2023).

* Burial of the OSS-link cable would typically target a depth of 4 to 6 feet below the seafloor. The target burial depth for the OSS-link cable would be determined based on an assessment of seafloor conditions, seafloor mobility, the risk of interaction with external hazards such as fishing gear and vessel anchors, and a site-specific cable burial risk assessment.

† The disturbance corridor reflects the maximum area that would be subject to seafloor preparation prior to cable installation.

Table 2.1-5. Maximum Seafloor Disturbances for Offshore Substation-Link Cable Installation

OSS-Link Cable Disturbance	Construction Footprint	Operation Footprint
General disturbance corridor*	148 acres	–
Boulder clearance (60% of total length)	89 acres	–
Secondary cable protection (10% of total length)	–	4.4 acres

Source: VHB (2023).

Notes: Disturbance estimates presented in this table are not additive because disturbance types may overlap (e.g., cable protection placed in areas where boulders were cleared). Vessel anchoring disturbances are not included; if anchoring (or a pull ahead anchor) is necessary during cable installation, it would occur within the APE and be centered on cable routes. The maximum depth of disturbance associated with anchoring is 15 feet (4.6 m), except between Kilometer Post 0 and 10.5 where it is 18 feet (5.5 m). It is estimated that up to 390 pull-ahead anchoring events would occur, 200 of which would occur in the RWEC-RI corridor, 150 would occur in the RWEC-OCS corridor, and 40 would occur for OSS-link installation, accounting for approximately 16 acres of seafloor disturbance within the 131-foot-wide (40-m-wide) disturbance corridor.

* The general disturbance corridor width for the OSS-link cable is 131 feet. Boulder clearance and secondary cable protection would not extend beyond this corridor. Also, if performed along the OSS-link cable route, boulder clearance and cable lay and burial trials would occur within this general disturbance corridor.

2.1.2.1.7 Inter-Array Cable Protection and Offshore Substation-Link Cable Protection

Cable protection in the form of rock berms, rock bags, and/or mattresses would be installed on the IAC and OSS-link cable where burial cannot occur, where sufficient burial depth cannot be achieved because of seafloor conditions, or to avoid risk of interaction with external hazards as determined necessary by the cable burial risk assessment, and where the cables cross existing submarine assets.[8] Cable protection would be installed from an anchored or dynamic positioning support vessel that would place the protection material over the designated area or areas. BOEM has not identified a preferred or required form of scour protection; however, proposed mitigation measures outlined in Appendix F (Environmental Protection Measures, Mitigation, and Monitoring) (see Table F-2) include requirements to the types of cable protection used consistent with *BOEM's Guidelines for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR Part 585* (BOEM 2022b).

The COP estimates up to 10% of the route for each IAC would require cable protection. Rock berm or concrete mattress separation layers would be installed over existing submarine assets prior to installing a

[8] Submarine assets include infrastructure such as pipelines, tunnels, or cables (transmission, fiber optic, telecommunication, etc.) that are buried below the seafloor.

crossing cable, whereas additional rock berm or concrete mattress cover layers would be installed over the crossing cable after cable installation. Similar to the IAC, the COP estimates up to 10% of the OSS-link cable route would require cable protection in areas where burial cannot occur, where sufficient burial depth cannot be achieved due to seafloor conditions, or to avoid risk of interaction with external hazards. Rock would also be used as a stabilizer for the IAC and OSS-link cable at the point of cable entry to the WTG and OSS foundations. Details on the anticipated seafloor disturbance and secondary cable protection information is outlined in Table 4-1 of COP Appendix X2 (Inspire Environmental 2023).

Cable protection at cable crossings would be applied for both in-service assets as well as out-of-service submarine assets (i.e., assets not currently in use or abandoned in place) that cannot be safely removed and pose a risk to the IAC. Up to 1,640 feet of cable protection would be required per crossing. However, final crossing designs would be completed in coordination with submarine asset owners and formalized in crossing and proximity agreements, in line with International Cable Protection Committee recommendations (COP Section 3.3.3.2). No cable crossings are anticipated for the IAC or OSS-link cable.

Revolution Wind would provide the location of all cables and associated cable protection to NOAA's Office of Coast Survey after installation for inclusion on nautical charts (COP Section 3.3.3.2).

2.1.2.1.8 Operations and Maintenance Facilities

Revolution Wind is evaluating five sites for the location of the O&M facility or facilities that would support the Project. The five sites under consideration are located at existing ports listed in Table 2.1-6 (also see COP Section 3.5.6 and COP Table 3.3.10-1). Revolution Wind could use one or more of these sites to fulfill the Project O&M facility requirements. Any potential modifications at the ports to establish an O&M facility or O&M facilities are outlined in Table 2.1-6.

Table 2.1-6. Potential Operations and Maintenance Facility Locations and Descriptions

Potential O&M Facility Sites	Description of Site-Specific O&M Facilities
Port of Brooklyn (New York)	There are no plans to construct new O&M buildings at, or otherwise implement improvements to, the Port of Brooklyn, and use of this port as an O&M facility is assumed to be limited to use of existing facilities maintained by the port.
Port of Davisville at Quonset Point (Rhode Island)	As described and evaluated in the South Fork Wind Farm COP (Jacobs Engineering Group [Jacobs] 2021), new O&M building(s) with up to 1,000 square feet of office space and up to 11,000 square feet of equipment storage space would be constructed at the Port of Davisville at Quonset Point. This building may serve as an O&M base for multiple offshore wind projects.
Cashman Shipyard (Massachusetts)	There are no plans to construct new O&M buildings at, or otherwise implement improvements to, the Cashman Shipyard, and use of this port as an O&M facility is assumed to be limited to existing facilities maintained by the port.

Potential O&M Facility Sites	Description of Site-Specific O&M Facilities
Port Jefferson (New York)	There are no plans to expand or construct new O&M buildings at Port Jefferson. An existing upland building within an office park (Research Way) that includes other businesses would serve as a regional O&M hub and headquarters for Orsted and multiple offshore wind projects. There are plans to conduct internal upgrades to the building to establish O&M office and warehouse space that would similarly support multiple offshore wind projects.
Port of Montauk (New York)	New O&M building(s) with up to 1,000 square feet of office space and up to 6,000 square feet of equipment storage space would be constructed at the Port of Montauk.

Source: VHB (2023)

Note: O&M buildings at/near some or all of these ports will be used for wind farm monitoring and equipment storage for multiple offshore wind projects including the RWF, SFWF, and Sunrise Wind Farm, and as such have utility that is independent of the Project.

2.1.2.1.9 Port Facilities

The Project would use a combination of existing port facilities located in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Virginia, and Maryland for offshore construction, assembly, and fabrication, and/or crew transfer and logistics support. Modifications of these ports are specifically not included in the Proposed Action because no expansions or modifications to the ports are needed to support vessels, helicopters, equipment, or supplies associated with Project activities. Final port selection has not been determined at this time; Table 2.1-7 provides a summary of the potential ports that could be used to support the Project.

Table 2.1-7. Potential Port Facilities and Summary of Potential Activities

State	Port	City/Town, County	WTG Tower, Nacelle, and Blade Storage, Pre-Commissioning and Marshalling	Foundation Marshalling and Advanced Foundation Component Fabrication	Construction Hub and/or O&M Activities	Electrical Activities and Support
New York	Port of Montauk	Montauk, Suffolk County			X	
	Port Jefferson	Port Jefferson Village, Suffolk County			X	
	Port of Brooklyn	Brooklyn, Kings County			X	
Rhode Island	Port of Providence	Providence, Providence County	X	X	X	X
	Port of Davisville at Quonset Point	North Kingstown, Washington County			X	
Connecticut	Port of New London	New London, New London County	X			
Virginia	Port of Norfolk	Norfolk City, Norfolk County	X			
Massachusetts	New Bedford Marine Commerce Terminal	New Bedford, Bristol County	X			
	Cashman Shipyard	Quincy, Norfolk County			X	
Maryland	Sparrow's Point	Sparrow's Point, Baltimore County		X		
New Jersey	Paulsboro Marine Terminal	Paulsboro, Gloucester County		X		

2.1.2.2 Revolution Wind Export Cable Components

Power from the RWF would be delivered to the electric grid by two distinct transmission cable segments: the RWEC (offshore component) and the onshore transmission cable (onshore component). The RWEC corridor traverses both federal and Rhode Island state waters before reaching landfall (see Figure 1.1-1). Table 2.1-8 summarizes the RWEC components, which are described in more detail in the sections that follow. Additional information is provided in Appendix D (Project Design Envelope and Maximum-Case Scenario). Figure 2.1-7 (COP Figure 1.1-2) provides a simplified Project schematic showing the components of the RWEC that deliver electricity from the OSS to the existing Davisville Substation.

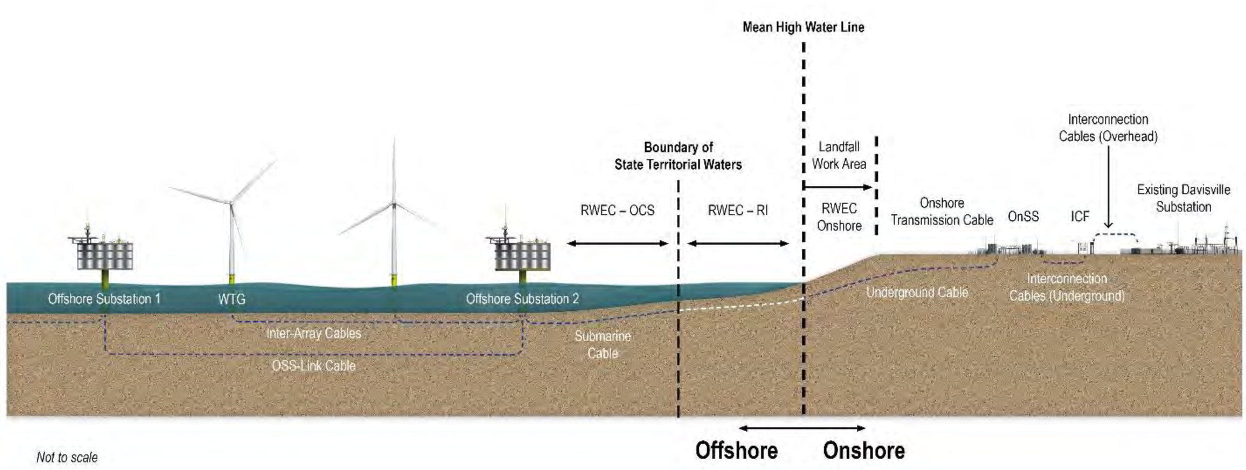


Figure 2.1-7. Simplified Project schematic (VHB 2023).

Table 2.1-8. Revolution Wind Export Cable Components and Footprints

Project Component	Location	Project Envelope Characteristic	Construction and Installation Footprint (temporary)	Operation Footprint (permanent)
RWEC	RWEC offshore segment in federal waters (RWEC-OCS) and RWEC offshore segment in state waters (RWEC-RI)	Up to two 275-kV cables (one for each OSS) with a diameter of 11.8 inches and a target burial depth of 4 to 6 feet, a maximum disturbance depth of 13 feet, and a maximum disturbance corridor width of 131 feet per cable Total cable length up to 42 miles per cable with the RWEC-OCS segment totaling up to 19 miles and the RWEC-RI segment totaling up to 23 miles of each cable in Rhode Island state waters and extending to landfall The RWECs would be located within the same corridor. Offshore and based on site-specific conditions (e.g., water depth and seabed constraints), each cable would typically be spaced greater than 164 feet apart; spacing between each cable would be less at landfall (e.g., approximately 23–49 feet).	RWEC-OCS:* Cable lay and burial trials (5 per cable estimate) = 12.4 acres General disturbance corridor = 593.1 acres Omega joint installation (2 per cable) = 20.4 acres Boulder clearance (40% of route for two cables) = 237.2 acres RWEC-RI:* Cable lay and burial trials (5 per cable estimate) = 12.4 acres General disturbance corridor = 731.4 acres Omega joint installation (2 per cable) = 20.4 acres Boulder clearance (70% of route for two cables) = 512 acres	RWEC-OCS (10% would require secondary protection) = 17.8 acres RWEC-RI (5% would require secondary protection) = 11.0 acres
RWEC cable protection	RWEC-OCS and RWEC-RI	In the form of rock berms, concrete mattresses, fronded mattresses, and/or rock bags, as follows: Cable protection for RWEC-OCS for 10% of OCS route length and 5% of RWEC-RI route length, up to 39.4 feet wide Cable protection for existing submarine assets (seven identified) anticipated to	RWEC-OCS (10% of route) = 17.8 acres RWEC-RI (5% of route) = 11 acres Existing submarine assets (seven identified) anticipated to be crossed by RWEC-RI = 21.9 acres	RWEC-OCS = 17.8 acres RWEC-RI = 11.0 acres Existing submarine assets = 21.9 acres

Project Component	Location	Project Envelope Characteristic	Construction and Installation Footprint (temporary)	Operation Footprint (permanent)
		be crossed by RWEC: up to 4.4 miles in length, up to 39.4 feet wide		
RWEC (onshore transmission cable)	Onshore	Two 275-kV cables spliced into two 275-kV transmission circuits with three cables each (total of six cables in two circuits) Diameter of 5.1 inches with a target burial depth of 3 to 6 feet, a maximum disturbance depth of 13 feet, and an approximate disturbance corridor width of 25 to 30 feet Two splice vaults per cable with maximum disturbance depth of 16 feet, and a disturbance area of 30 × 70 feet Trench width within this disturbance corridor of approximately 8 feet Cable length up to 1.0 mile	Temporary ground disturbance: 3 acres	RWEC operational ROW: 20 feet wide centered on the cable approximately 1 mile in length = 2.4 acres
Landfall work area	RWEC-RI and onshore Quonset Point North Kingstown, Rhode Island	Landfall work area (includes transition joint bays, with horizontal directional drilling (HDD) exit pits and cofferdams)†	3.1 acres‡	N/A
Landfall work area	RWEC-RI and onshore Quonset Point North Kingstown, Rhode Island	Transition joint bay	1,340 square feet	N/A
Landfall work area	RWEC-RI and onshore Quonset Point North	HDD exit pits and temporary cofferdams	0.24–0.94 acre	N/A

Project Component	Location	Project Envelope Characteristic	Construction and Installation Footprint (temporary)	Operation Footprint (permanent)
	Kingstown, Rhode Island			
OnSS	Onshore	Two 275-kV onshore transmission circuits transitioning to aboveground and terminating at the OnSS at two aboveground circuit terminals OnSS nominal operating capacity ranging between 704 and 880 MW, connecting to the ICF with two 115-kV underground transmission cables Maximum height of OnSS equipment up to 45 feet and shielding masts up to 65 feet	Up to 7.1 acres with maximum depth of disturbance of 60 feet	OnSS equipment: 3.8 acres OnSS facility: 7.1 acres§ Underground transmission cable (connecting to ICF) operational ROW: 20 feet wide centered on the cable approximately 527 feet in length = 0.24 acre
ICF	Onshore	ICF nominal operating capacity of up to six 115-kV breakers, connecting to the Davisville Substation with two 115-kV overhead transmission circuits Maximum height of ICF equipment up to 45 feet and shielding masts up to 55 feet Maximum height of overhead transmission circuit structures (ICF to Davisville Substation) up to 60 feet Maximum height of overhead transmission circuit structures (ICF to rebuilt Davisville Transmission Tap line) up to 80 feet	Approximately 4.0 acres with a maximum depth of disturbance of 60 feet	Up to 1.6 acres Overhead transmission circuit (ICF to Davisville Substation) ROW: Up to 120-foot-wide cleared ROW centered on the circuit for two circuits approximately 474 feet in length = 1.3 acres Overhead transmission circuit (ICF to rebuilt Davisville Transmission Tap line) ROW: Up to 120-foot-wide cleared ROW centered on the circuit for approximately 712 feet in length = 1.9 acres

Source: VHB (2023).

Note: For a detailed description of assumptions used to develop the footprint estimates, see COP Tables 3.3.1-3, 3.3.2-1, 3.3.3-1, 3.3.3-3, 3.3.3-5, 3.3.4-1, 3.3.4-2, 3.3.5-1, 3.3.6-1, 3.3.6-2, 3.3.7-1, and 3.3.7-2.

* Disturbance estimates are not additive because disturbance types may overlap.

† A cofferdam is a watertight enclosure pumped dry to permit construction work below the waterline.

‡ Transition joint bays and HDD exit pits with cofferdams would occur within the landfall work area. The PDE includes four HDD construction methods that vary in area of disturbance from 0.12 to 0.47 acre. Both export cables would use one of the HDD methods, for a combined area of disturbance at the landfall work area of 0.24 to 0.94 acre.

§ The OnSS facility would include a compacted gravel driveway, stormwater management features, and associated landscaped or managed vegetated areas totaling up to 7.1 acres inclusive of the OnSS equipment.

2.1.2.2.1 Offshore Segments

The RWEC would consist of up to two 275-kV high-voltage AC submarine cables, each originating at a respective OSS in the Lease Area but eventually located within a 1,640 foot-wide Project easement and extending to the landfall site in Quonset Point, Rhode Island. (see Figure 1.1-1). Offshore, based on site-specific conditions (e.g., water depth and seafloor constraints), each cable of the RWEC would be spaced, where practical, greater than 164 feet apart; spacing between each cable would be less at landfall (e.g., approximately 23 to 49 feet). Similar to the IAC (see Section 2.1.2.5), each cable of the RWEC would consist of three bundled copper or aluminum conductor cores surrounded by layers of insulation and various protective armoring and sheathing to protect the cable from external damage. Fiber-optic cables would also be included in the interstitial space between the three conductors for continuous monitoring of the RWF (i.e., one fiber-optic cable per RWEC cable bundle). A cross section of a typical submarine cable is provided in COP Figure 3.3.3-2. The maximum design scenario for the RWEC is provided in COP Table 3.3.3-1 and included in Appendix D of this EIS. Target burial depth below the seafloor for the RWEC would be 4 to 6 feet with a maximum disturbance depth of 13 feet. Cable installation surveys would be required, including pre- and post-installation surveys, to determine the actual cable burial depth.

2.1.2.2.2 Offshore Cable Protection

The COP estimates that up to 10% of the route for each offshore cable type (RWEC-OCS, OSS-link cable, IAC) would require cable protection, except for the RWEC-RI, which is estimated to require cable protection for 5% of the route. Seven known submarine assets exist along the RWEC (refer to Appendix E for discussion and Figure 3.17-1 in Other Marine Uses). See Figure 1.1-1 for a depiction of the potential grid layout of WTGs and OSSs with OSS-link cable and IACs.

The amount of cable protection for existing submarine assets would be as required for suitable coverage and technical agreements with respective asset owners. See Section 2.1.2.1.7 for a discussion of cable protection measures and when they are deployed.

Revolution Wind would provide the location of all cables and associated cable protection to NOAA's Office of Coast Survey after installation for inclusion on nautical charts (COP Section 3.3.3.2).

2.1.2.2.3 Onshore Segments

The onshore segment of the RWEC (the onshore transmission cable) originates where the offshore segment of the RWEC comes ashore in the landfall work area, transitions from two larger diameter cables to six smaller diameter cables, running in two parallel circuits in the same trench, and proceeds underground to the OnSS and the ICF. Two fiber-optic cables would also be included in the interstitial space between the six cables for the length of the onshore transmission cable for monitoring. Up to two splice vaults would be required for each circuit (up to four total) of the onshore transmission cable between landfall and the OnSS. See COP Figure 3.3.2-2 and Figure 3.3.2-1 for illustrations of the onshore transmission cable cross section and circuit configuration. See Figure 2.1-2 (COP Figure 2.2.1-3) for the proposed location of the onshore transmission cable path, OnSS, ICF, and onshore work areas. Additional details of the onshore transmission cable design are found in Section 3.3.2 of the COP.

Landfall Work Area

There are different locations within the approximate 20-acre landfall envelope that are being evaluated for the landfall work area (see Figure 2.1-2). The landfall envelope is a roughly rectangular polygon bounded by Whitecap Drive on the west, Circuit Drive on the north, the Electric Boat property on the east, and Narragansett Bay on the south.

Installation of the RWEC at the landfall work area would be accomplished using a horizontal directional drilling (HDD) methodology originating onshore to the seaward exit pit in Rhode Island state waters and may incorporate a temporary cofferdam or a temporary surface casing with supporting goal posts (see Table 2.1-8). If needed, based on site conditions at the landfall work area, a cofferdam would be used to create a dry environment during construction and to manage sediment, contaminated soils, and bentonite (for HDD operations). The cofferdam, measuring up to 164 × 33 × 10 feet to align with HDD exit pits, could be installed as either a sheet piled structure into the seafloor or a gravity cell structure placed on the seafloor using ballast weight, and installation would be conducted from an offshore work barge anchored near the cofferdam. A barge could be required to anchor at or near the exit point of the HDD duct during construction, regardless of whether a cofferdam is used or not. One cofferdam would be needed for each of the two cables that make up the RWEC. Alternatively, instead of a cofferdam, an exit pit with or without the use of surface casing pipe and goal posts measuring up to 182 x 113 x 10 feet would be deployed. The area of ground and seafloor disturbance estimated for construction at the RWEC landfall location is 3.1 acres. See COP Section 3.3.3.2 for further details on the construction methods available under the PDE for use with HDD operations.

Whether or not a cofferdam is necessary for cable installation (via HDD operations), vessel anchoring could be required for cable installation at the landfall. If needed, anchoring would occur within a 1,640-foot-wide Project easement centered on the cable routes (see COP Section 3.3.9.2 for additional information on vessel anchoring).

As the RWEC is brought onshore, the intersection of the RWEC and onshore transmission cable would occur at up to two co-located transition joint bays (one for each cable of the incoming RWEC) constructed in the landfall work area. A conceptual schematic of the transition joint bays is provided in COP Figure 3.3.3-1. Transition joint bays comprise pits that are dug in the soil and lined with concrete. The purpose of a transition joint bay is to provide a clean, dry environment for the jointing of the RWEC and onshore transmission cable as well as to protect the joint once the jointing is completed. Each of the co-located transition joint bays would be up to 67 × 10 × 10 feet.

Within each transition joint bay, the incoming RWEC (offshore) cable would be spliced into three onshore cables. The sheaths from the RWEC and the onshore transmission cable would be terminated into the link box via the cable joints. The fiber-optic cables from the RWEC and onshore transmission cable would be joined inside the fiber-optic joint box. In total, there would be two transition joint bays, each with one link box and one fiber-optic cable joint box (Figure 2.1-8 [COP Figure 3.3.3-1]).

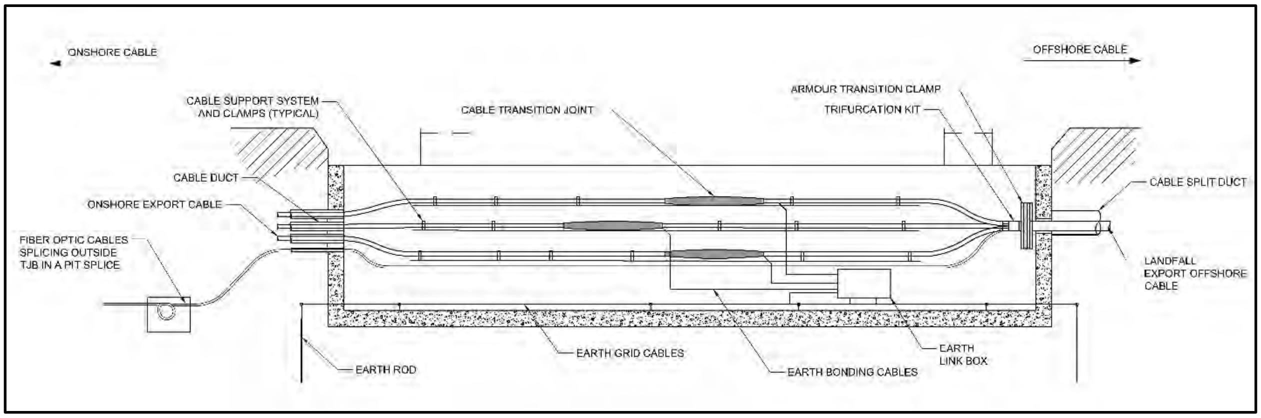


Figure 2.1-8. Transition joint bay and link box schematic (VHB 2023).

Access to the fiber-optic handhole and link box handhole near the transition joint bays during the operational phase would be via manhole covers. A precast splice vault could also be used as an alternative to transition joint bays. The precast splice vault would consist of dimensions similar to the transition joint bays; however, the splices would be housed in a precast enclosure on all sides, with manhole risers and covers for access from grade. The amount of ground disturbance would be similar between the two options.

Onshore Transmission Cable

Regardless of the specific landfall site selected, the onshore transmission cable would travel from the landfall work area approximately 1 mile to the OnSS, trending northwest to the OnSS via Circuit Drive. Refer to Figure 2.1-2 (COP Figure 2.2.1-3) for an illustration of the landfall location and onshore cable route.

Onshore Substation and Interconnection Facility

A new OnSS and ICF adjacent to the existing Davisville Substation would be constructed to support interconnection of the Project to the existing electrical grid. The OnSS would be equipped with two aboveground circuit terminals that are connected to the 275-kV substation equipment. The onshore transmission cable would terminate at these steel structures, transitioning them from underground to above ground and thereby completing the connection to the OnSS.

Circuit connections would include an interconnection ROW between the OnSS and the ICF and the TNEC ROW, thus bridging the ROW gap between the ICF and the existing Davisville Substation. The OnSS would connect to the ICF with up to two 115-kV underground transmission cables located within the interconnection ROW that are each up to 527 feet long. The TNEC ROW would require an up to 120-foot-wide cleared ROW centered on each circuit to be maintained free of woody vegetation that exceeds 20 feet in height.

Onshore Substation

The OnSS would have a nominal operating capacity between 704 and 880 MW. The maximum height of the OnSS equipment would be up to 45 feet, with shielding masts measuring up to 65 feet tall. The OnSS would be located on two adjacent parcels totaling 15.7 acres, both owned by the Rhode Island Commerce Corporation and include a compacted gravel driveway, stormwater management features, and associated landscaped or managed vegetation areas totaling up to 7.1 acres inclusive of the up to 4-acre operational footprint of the facility. Backup power for the OnSS would be provided via a 50-kW generator fed by portable propane tanks.

Interconnection Facility

The ICF would be located on a 6.1-acre parcel (owned by TNEC) adjacent to the OnSS and occupy an operational footprint of up to 1.6 acres. The maximum height of ICF equipment would be up to 45 feet, with shielding masts measuring up to 55 feet tall. Additionally, the ICF would include an asphalt paved driveway, stormwater management features, and associated landscaped or managed vegetated areas. The limit of work associated with development of the ICF totals up to 4.0 acres.

The Davisville Substation would serve as the point of interconnection for the Project. The ICF would connect to the Davisville Substation with two 115-kV overhead transmission circuits located within the TNEC ROW. The transmission lines from the ICF to the Davisville Substation would be up to 474 feet long and would be supported on single-circuit structures measuring up to 60 feet tall. A short segment of the existing 115-kV Davisville Transmission Tap line would also be rebuilt as part of ICF construction. The transmission line from the ICF to the Davisville Transmission Tap line would be up to 712 feet long. The two circuits would be supported on a combination of single- and double-circuit structures measuring up to 80 feet tall.

As part of the Project, the 115-kV side of the Davisville Substation would be expanded to a 115-kV six-breaker ring bus to enable a more reliable connection between the Project (two 115-kV underground duct bank connections), the existing Davisville Substation, and the ISO New England transmission system. The six-breaker ring bus would include an air-insulated system consisting of circuit breakers, disconnect switches, structural steel, instrument and station service transformers, and associated miscellaneous equipment (i.e., insulators, surge arresters, electrical fittings, and hardware). To support more timely cutovers, a new prefabricated control house would also be installed. Major equipment associated with the ICF is summarized in COP Table 3.3.1-3.

The ICF would contain small amounts of oils, fuels, and lubricants to support operations. Sulfur hexafluoride gas could be used for electrical insulation in some switchgear components, such as in the ICF. Appendix E, Table E4-1 (and COP Table 3.3.1-4) provides a summary of maximum potential quantities of oils, fuels, lubricants, and sulfur hexafluoride gas located in the ICF during operations.

2.1.2.3 Construction and Installation

Construction and installation of the RWF and RWEC are scheduled to take place over 2 years within applicable seasonal work windows. Construction could begin as early as the third quarter of 2023 with the installation of onshore components and initiation of seafloor preparation activities. Approximate construction durations for the different Project components are provided in Figure 2.1-9, with some expected to overlap.

Figure 2.1-9. Revolution Wind Farm indicative construction schedule (VHB 2023).

2.1.2.3.1 Offshore Activities and Facilities

Vessels and Vehicles

Construction of the Project would require the support of offshore construction equipment, various vessels, and helicopters that are identified by port in Table 2.1-9 and Table 2.1-10. Equipment, vehicle, and vessel types, and quantity needed for offshore and onshore construction, are identified by Project components in Table 2.1-11 and Table 2.1-12. See COP Section 3.3.10-2 for a discussion of the number and type of vessels and vehicle trips by various onshore and offshore construction tasks.

Table 2.1-9. Summary of Revolution Wind Farm Marine Vessel Type and Usage for Offshore Construction and Operations and Maintenance by Port

Project Phase	Project Component	Port Used	Vessels (counts)
Installation	WTGs	Port of Providence, Rhode Island, or Port of New London, Connecticut, or Port of Norfolk, Virginia, or New Bedford Marine Commerce Terminal, Massachusetts	Jack-up installation vessel (1) Jack-up feeder vessel (2) SOV (1) CTV (3) Feeder barge (6) Tow tug (6)
Installation	Foundations	Port of Providence, Rhode Island, or Sparrow's Point, Maryland, or Paulsboro Marine Terminal, New Jersey, or from Europe	Jack-up installation vessel (1) Foundation supply vessel (7) Material barge (6) Feeder barge (6) Tow tug (6) Anchor handling tug (4) CTV (4) Support vessel – inflatable (2) Rock installation vessel (1) Bunkering vessel (1)
Installation	OSS	Port of Providence, Rhode Island, or Sparrow's Point, Maryland, or Paulsboro Marine Terminal, NewJersey	Foundation installation vessel (1) Heavy transportvessel (1) CTV (3)
Installation	IAC	Port of Providence, Rhode Island	Cable laying vessel – array (1) Array cable burial vessel (1) Transport freighter (1) CTV (1) SOV (1) Pre-lay grapnel run vessel (1)

Project Phase	Project Component	Port Used	Vessels (counts)
			Survey vessel (1) Support tug (1)
Installation	OSS-LinkCable	Port of Providence, Rhode Island	CTV (1) SOV (1) Pre-lay grapnel run vessel (1) Survey vessel (1) Cable laying vessel – export (1) Support tug (1) Anchor handling tug (1)
O&M	O&M	Port of Montauk, New York, or Port Jefferson, New York, or Port of Brooklyn, New York, or Port of Davisville at Quonset Point, Rhode Island, or Cashman Shipyard, Massachusetts	SOV (2) SOV daughter craft (2) CTV (5) WTG installation vessel (1) Cable laying vessel – array (1)

Source: Tech Environmental (2023).

Table 2.1-10. Summary of Revolution Wind Farm Helicopter Type and Usage for Offshore Construction and Operations and Maintenance by Port

Project Phase	Project Component	Port Used	Helicopter Types (counts)
Installation	Foundations	Port of Davisville at Quonset Point, Rhode Island	Twin medium (2)
O&M	O&M	Port of Davisville at Quonset Point, Rhode Island or Cashman Shipyard, Massachusetts	Twin medium (1)

Source: Tech Environmental (2021).

Table 2.1-11. Summary of Revolution Wind Farm Marine Vessel Type and Usage for Offshore Construction and Operations and Maintenance by Project Component

Vessel Type	No. of Vessels	Foundations	OSS	RWEC	IAC	OSS-Link Cable	WTGs	No. of Return Trips
Anchor handling tug	2	X		X		X		50
Boulder clearance vessel	2	X	X	X	X	X		13
Bubble curtain vessel	1	X						20
Cable burial vessel	1				X	X		6
Cable burial vessel – remedial	1			X				1
Cable lay & burial vessel (export)	1			X				5
Cable lay vessel (barge)	1			X				3
Cable laying vessel	1				X	X		6
Crew transfer vessel (CTV)	6	X	X	X	X	X	X	870
Dp2 construction vessel	2			X	X	X		7
Fall pipe vessel	1	X						6
Fuel bunkering vessel	1						X	8
Guard vessel/scout vessel	6	X	X	X	X	X		8
Heavy lift installation vessel	1	X						1
Heavy lift installation vessel (secondary steel)	1	X						1
Heavy transport vessel	5	X	X					26
Helicopter	1-2	X	X				X	76
Jack-up installation vessel	1						X	20
Life boat – jack-up accommodation vessel	1	X	X	X	X	X	X	1

Vessel Type	No. of Vessels	Foundations	OSS	RWEC	IAC	OSS-Link Cable	WTGs	No. of Return Trips
Platform supply vessel	3	X						85
Pre-lay grapnel run vessel	2			X	X	X		6
Protected species observer noise monitoring vessel	4	X						80
Safety vessel	2	X	X	X	X	X	X	100
SOV	2	X	X	X	X	X	X	7
Supply barge	1	X		X	X	X		4
Supply vessel	1	X	X	X	X	X	X	30
Survey vessel	1			X	X	X		11
Tow tug	5	X					X	29

Source: VHB (2023).

Table 2.1-12. Summary of Revolution Wind Farm Vehicle and Equipment Type and Quantity for Onshore Construction and Operations and Maintenance by Project Component

Equipment Type	Number of Units
OnSS	
Large bulldozer	2
Small bulldozer	1
Backhoe	2
Front end loader	3
Small crane	1
Medium excavator	3
Compactors	5
Concrete saws	4
Pumps	6
AC units	4
Compressors	2
Semi-truck	40
Refuse truck	2
Dump truck	50
Concrete truck	200
Bucket truck	2
Light commercial truck	51
Passenger truck	25
Landfall – HDD Installation	
Generator/powerpack (1,305 kw)	1
Crane (205 kw)	1
Dump truck	1
Excavator (132 kw)	1
Onshore Transmission Cable	
All-terrain forklift	3
Large excavator	2
Concrete vibrator	4
Generator	5
Welder	1
WTG Assembly	

Equipment Type	Number of Units
Crane (641 kw)	3
Crane (241 kw)	1
Self-propelled modular trailer	2
Forklift (130 kw)	2
Forklift (60 kw)	1
Cherry picker	2
Reach stacker	2
Generator	2
Blade movers	2
Site vehicles	3

For each vessel type, the route plan for the vessel operation area would be developed to meet industry guidelines and best practices in accordance with International Chamber of Shipping guidance. Revolution Wind would require operational automatic identification systems (AIS) onboard all vessels associated with the construction of the Project. AIS would be used to monitor the number of vessels and traffic patterns for analysis and to ensure compliance with vessel speed requirements as appropriate in accordance with NOAA requirements. All vessels would operate in accordance with applicable rules and regulations for maritime operation within state and federal waters. Similarly, all aviation operations, including flying routes and altitude, would be coordinated with relevant stakeholders (e.g., the FAA). Project vessels would employ a variety of anchoring systems, which include a range of sizes, weights, mooring systems, and penetration depths. Although dynamic positioning support vessels would be used for cable laying, vessels could anchor within a 1,640-foot-wide Project easement centered on cable routes. Anchors associated with cable laying vessels would have a maximum penetration depth of 15 feet. Jack-up vessels for foundation and WTG installation would include up to four spudcans with a maximum penetration depth of 52 feet. Jack up would occur within the 656-foot radius cleared around foundation locations during seafloor preparation activities (see Appendix D for additional design details).

Some large Project components, as well as secondary equipment, supplies, and crew, would be transported to and from the RWF from existing ports. Helicopters could be used for crew changes during installation of the WTGs.

Construction and installation lighting would be limited to the minimum necessary to ensure safety and compliance with applicable FAA and U.S. Coast Guard (USCG) requirements while using lighting technology (e.g., low-intensity strobe lights) that minimizes impacts on sensitive receptors. USCG-approved navigation lighting is required for all vessels during construction and decommissioning of the Project. All vessels operating between dusk and dawn are required to turn on navigation lights. Cable laying may occur 24 hours a day during certain periods. Additionally, adequate lighting would be used on vessels to ensure worker safety throughout construction, including for foundation, WTG, OSS, and cable installation. As is required under International Maritime Organization (IMO) requirements for vessels over 500 gross tonnage, the deck area of vessels would be illuminated for the safety of operations and personnel during installation and as needed during transit to facilitate ongoing work on deck. Vessel lighting would be sufficient to meet IMO convention requirements, but the use of any unnecessary or excess lighting would be avoided.

Transportation and Installation of Foundations

Revolution Wind would transport large Project components, including the WTGs, the foundations, OSSs, and export cables, to an existing port for pre-assembly or storage prior to being delivered to the RWF, or they could be delivered directly from off-site fabrication and manufacturing facilities.

Before the foundations are installed, geophysical and geotechnical (G&G) surveys and munitions, explosives of concern, and unexploded ordnance (UXO) surveys would be conducted in addition to seafloor debris clearance. At the time of preparation of the Final EIS, Revolution Wind conducted final G&G surveys and UXO surveys of the RWF and RWEC. No UXOs were identified in the RWF. Sixteen UXOs were identified along the RWEC; however, Revolution Wind determined that all 16 UXOs would be avoided without the need for detonation (Orsted 2023). Figure 2.1-10 shows locations of the 16 UXOs as identified and numbered by Revolution Wind. Monopile foundations would be driven to target embedment depths (98 to 168 feet below the seafloor) using impact pile driving and/or vibratory pile driving.

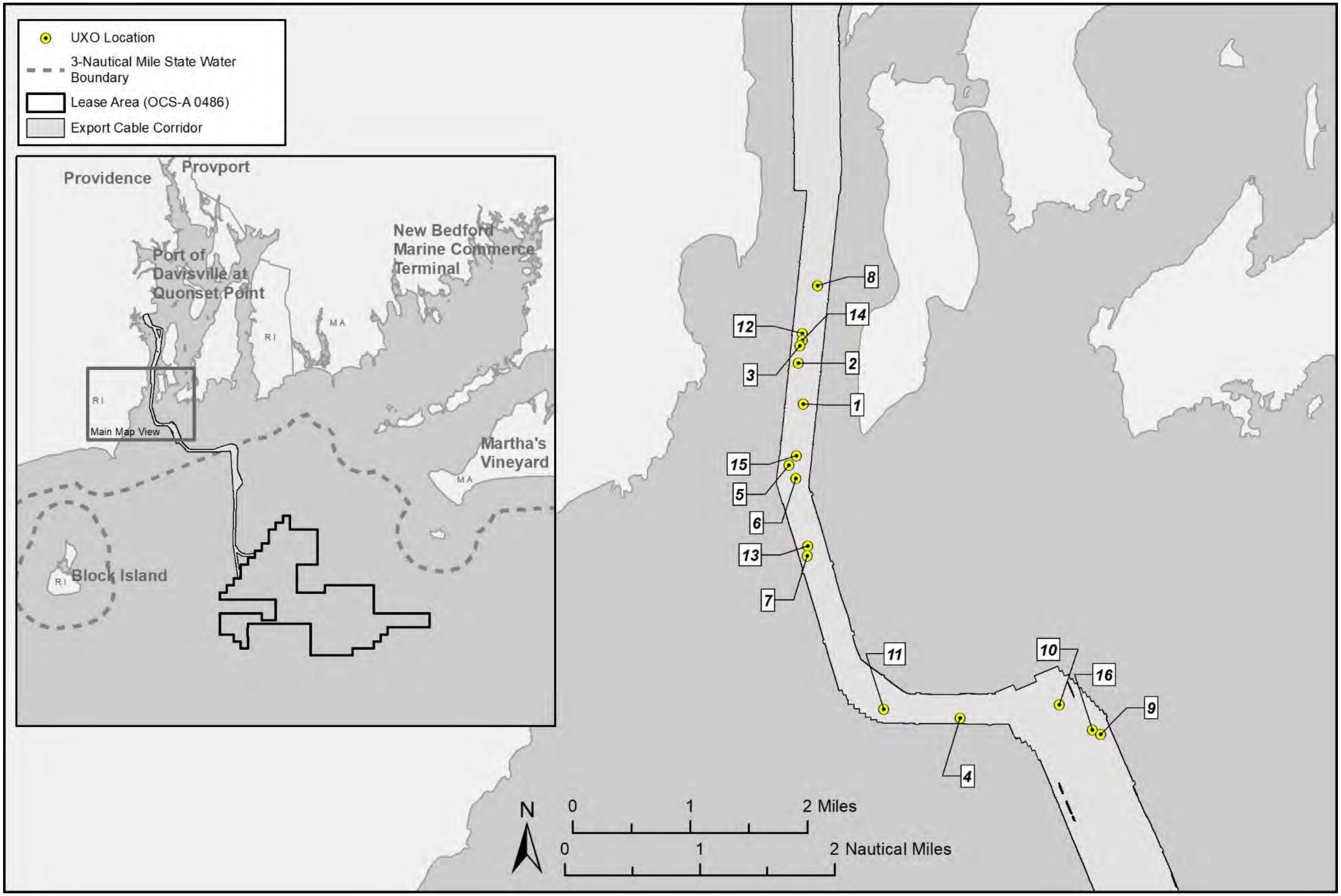


Figure 2.1-10. Unexploded ordinance identified in the Revolution Wind Export Cable corridor.

Typical installation sequence for monopile foundations would include foundation delivery, foundation setup, pile driving, and transition piece installation or secondary structure installation (COP Table 3.3.4-3). Installation of a single monopile foundation is estimated to require 1 to 4 hours (6 to 12 hours maximum) of pile driving with a maximum hydraulic hammer energy at 4,000 kilojoules (kJ). Up to three monopile foundations would be installed in a 24-hour period. The WTG monopile installation is expected to be completed in a single 5-month period (see Appendix D for additional design details).

Scour protection would be installed prior to installation of the foundations. If rock placement scour protection is used, a rock armor layer resting on a filter layer would be installed. The filter layer can either be installed before the foundation is installed (pre-installed) or afterward (post-installed). Alternatively, by using heavier rock material with a wider gradation, it is possible to avoid using a filter layer and pre- or post-install a single layer of scour protection. The amount of scour protection required would be based on local site conditions. The final choice and design of a scour protection solution for the Project would be made after detailed design of the foundation structure, taking into account a range of aspects, including geotechnical data, metocean data, water depth, foundation type, maintenance strategy, agency coordination, stakeholder concerns, and cost. However, the maximum anticipated area of scour protection per foundation is accounted for in permanent disturbance estimates provided in COP Table 3.3.4-1.

Wind Turbine Generators

WTG components would be transported to the laydown construction port to prepare components for loading and installation. Activities include pre-assembling tower sections as well as preparing the nacelles, blades, and equipment necessary for WTG installation. The WTGs would then be transported to the Lease Area by either an installation vessel or feeder vessel. The installation vessel would install the tower as a single lift, if preassembled, or in multiple lifts for separate sections. The tower would be bolted to the foundation. The nacelle would then be installed on top of the tower and bolted in place. The blades would be installed as a pre-assembled full rotor or in single lifts. Once the WTG installation is complete, the installation vessel would move on to the next WTG installation location. Commissioning of the turbine would be executed by commissioning technicians working from separate commissioning vessels. Installation of a WTG is estimated to take up to 36 hours, allowing for vessel positioning and completion of all lifts; however, to allow time for vessel maneuvering between WTG locations, as well as weather down time, the total duration of the installation campaign for the WTGs is expected to be approximately 5 months. Short-term construction-related seafloor disturbance for WTGs and OSSs would include boulder clearance. Vessel anchoring would also result in short-term seafloor disturbance and would occur within a 656-foot radius around WTG and OSS foundation locations. Additional WTG details are described in Section 2.1.2.1.1 and Appendix D.

Offshore Substations

Installation and commissioning of OSSs would occur within an 8-month window, including cable pull-in, which must be completed prior to OSS commissioning. Construction sequence for an OSS would include monopile foundation delivery and installation followed by topside installation and commissioning. The foundation delivery and installation process is discussed in Section 2.1.2.1.2. The topside platform, including the transformer module and switchgear, would be assembled as a single unit prior to being transported to the Lease Area via a heavy transport vessel or barge. After installation of the OSS foundation, the lift would commence using an installation vessel, and the topside platform would be lowered onto the foundation. The topside platform would then be secured into position by use of a grouted, bolted, or welded connection. Once the OSS topside is secured to the foundation, the RWEC, OSS-link cable, and IAC would be connected. Communication systems would also be set up with the shore as well as lighting, the firefighting system, etc. Once all systems are enabled, the electrical system would be commissioned using back-feed (i.e., electricity would be fed to the OSS from the onshore grid via the export cables).

Cable Systems

The IACs and the RWEC would be laid and buried using industry standard submarine cable lay and burial methods. The installation process for each cable system is described below. The methodologies for installation of the RWEC offshore and at the landfall work area are presented separately below.

Inter-Array Cables

The IACs would be installed within a 131-foot-wide disturbance corridor. Prior to main cable installation activities, cable lay and burial trials could occur within the disturbance corridor. The target burial depth for the IACs would be determined based on an assessment of seafloor conditions, seafloor mobility, the risk of interaction with external hazards such as fishing gear and vessel anchors, and a site-specific cable burial risk assessment. Prior to installation, seafloor preparation would include boulder clearance. The COP assumes that a boulder plow could be used in all areas of higher boulder concentrations where boulders are up to 1 m in diameter. For the IACs, the COP anticipates the use of a boulder grab for seafloor preparation, with contingency for a work-class, remotely operated vehicle with a boulder-pushing skid. A cable laying vessel would be preloaded with the IACs. Prior to the first end-pull, the cable would be fitted with a cable protection system, and the cable would be pulled into the WTG or OSS. The vessel would then move toward the next WTG (or OSS).

Cable laying and burial could occur simultaneously using a lay and bury tool, or the cable could be laid on the seafloor and then trenched post-lay. Alternatively, a trench could be precut prior to cable installation. The pull and lay operation, inclusive of fitting the cable with a cable protection system, would then be repeated for the remaining IAC lengths, connecting the WTGs and OSSs together. Burial of the IACs would target a depth of 4 to 6 feet below seafloor. During cable installation, scenarios could exist where installation to the target burial depth is not achievable using the primary installation methodologies due to mechanical problems with the trencher, adverse weather conditions, and/or unforeseen soil conditions. As a result, controlled flow excavation could be used and would involve using a stream of water to fluidize the sands around the cable, which allows the cable to settle into the trench under its own weight. No in-field joints would be used for IAC construction; however, they could be used in the case of cable repair. COP Section 3.3.7 provides design and construction details for the IACs. Refer to Section 2.1.2.3.7 for a discussion of IAC protection. The final installation methods and target burial depths would be determined by the final engineering design process, informed by detailed geotechnical data, discussion with the chosen installation contractor, and coordination with regulatory agencies and stakeholders. Detailed information on the final technique(s) selected would be submitted to and approved by BOEM through the facility design report/facility installation report review processes prior to construction.

Each IAC would typically take 1 day to lay and bury. Installation of the entire IAC network would be completed within a single approximately 5-month period (see Appendix D for additional design details).

Revolution Wind Export Cable Offshore Segments

Construction staging and installation for the offshore RWEC would generally be as described for the IACs. One exception would include methods used for removal or relocation of boulders along the RWEC. For the RWEC, the COP anticipates the use of a boulder grab for seafloor preparation with two approximately 10-km (6.2-mile) sections that would use a boulder plow. Dynamic positioning support vessels would be used for cable burial activities. Anchoring would occur within the Project easement, if used. Refer to Section 2.1.2.2 and Table 2.1-3 for details on the RWEC component construction and operational methods and footprints and Project easements.

Burial of the RWEC would target a depth of 4 to 6 feet below seafloor and would be determined based on an assessment of seafloor conditions, seafloor mobility, and the risk of interaction with external hazards such as fishing gear and vessel anchors, as described in Section 2.1.2.2.2. Cable protection methods, as described above, would be implemented where burial cannot occur. Installation of the RWEC would consist of a sequence of events, including pre-lay cable surveys, seafloor preparation, cable installation, joint construction, cable installation surveys, cable protection, and connection to the OSSs (summarized in COP Table 3.3.3-3). Installation of the RWEC would require offshore submarine joints (up to two per cable: one on the RWEC-OCS portion and one on the RWEC-RI portion). The joints would require a seafloor preparation corridor that is 820 × 673 feet. As a result, the anticipated disturbance corridor at the submarine joints of 673 feet wide would extend beyond the 131-foot-wide (40-m-wide) general disturbance corridor of the RWEC. The joints would be protected by housing approximately four times the cross-sectional diameter of the cable using similar methods as those described for cable protection. In case of the need for repair, additional joints may be required during construction. Construction of the RWEC would be completed within approximately 8 months (see Appendix D for additional design details).

Landfall Construction

As discussed in Section 2.1.2.2.3, installation of the RWEC at landfall would be conducted using an HDD methodology.

A drilling rig would be required for landfall construction and would be located within the landfall work area (COP Section 3.3.3.2). The HDD process would use drilling heads and reaming tools of various sizes controlled from the rig to create a passage that is wide enough to accommodate the cable duct. Drilling fluid, comprising bentonite, drilling additives, and water, would be pumped to the drilling head to stabilize the hole, prevent collapse, and return the cuttings to the rig site where the cuttings would be separated from the drilling fluids. A temporary sheet pile anchor wall could be installed to provide stability of the HDD rig while conducting drilling activities. The temporary anchor wall is driven to a depth of approximately 20 feet to secure the anchor. In addition to the anchor wall, the workspace could also require the installation of other temporary sheet piles to aid in the anchoring of the rig and/or to provide soil stabilization of the excavated area (VHB 2023).

Once the reaming has taken place, the duct (assembled off-site) would be floated to the site by tugs, connected to the drill string, and pulled into the prepared hole toward the drilling rig located at the landfall work area. The drilling rig would be repositioned, and the process would be repeated for drilling and installing the second duct. A pull winch attached to either a piled anchor or a gravity anchor (e.g., a large bulldozer) would then be used to pull the cable through the conduit.

Each of the two HDD cable ducts would have a diameter of 3 feet, and the maximum length of the cable ducts would be 0.6 mile. A barge or jack-up vessel could be used to assist the drilling process; handle the duct for pull-in; and help transport the drilling fluids and mud back to an appropriate site for treatment, disposal, and/or reuse. The jack-up vessel could also use a casing installed from the HDD exit pit to the jack-up vessel. Revolution Wind would develop an HDD contingency plan prior to construction to minimize potential risks associated with the inadvertent release of drilling fluids (see Appendix D for additional design details).

Offshore Substation-Link Cable

Installation of the OSS-link cable would require similar methods described above for construction of the RWEC offshore segments. The target burial depth for the OSS-link cable would typically be 4 to 6 feet below seafloor and would be determined based on an assessment of seafloor conditions, seafloor mobility, the risk of interaction with external hazards such as fishing gear and vessel anchors, and a site-specific cable burial risk assessment (see COP Sections 3.5.2 and 4.1.1). As discussed in Section 2.1.2.1.6, Revolution Wind assumes that up to 10% of the OSS-link cable route would require cable protection in areas where burial cannot occur, where sufficient burial depth cannot be achieved due to seafloor conditions, or to avoid risk of interaction with external hazards. As stated in the COP, Revolution Wind assumes that up to 60% of the total OSS-link cable route would require boulder clearance prior to installation of the cables. The location of the OSS-link cable and associated cable protection would be provided to NOAA's Office of Coast Survey after installation for inclusion on NOAA's nautical charts. The duration for installation of the OSS-link cable is included in the approximate 8-month window for OSS installation and commissioning.

2.1.2.3.2 Onshore Activities and Facilities

Vehicles

Construction of the Project would require the support of onshore construction equipment and vehicles provided in Table 2.1-13. See COP Section 3.3.10.2 for a discussion and listing of the number of vehicle trips by various construction tasks.

Table 2.1-13. Summary of Onshore Equipment Emission Sources

Project Phase	Project Component	Equipment Types (counts)
Pre-installation	WTGs	Crane – like LH 11350 (1) Crane (1) Crane (1) Crane (1) Self-propelled modular transporter on-site (1) Self-propelled modular transporter on-site (1) Forklift (2) Forklift (1) Cherry picker (2) Reach stacker (2) Generator (2) Blade mover (2) Site vehicle (3)

Source: Tech Environmental (2023)

Onshore Transmission Cable

Construction of the onshore transmission cable would involve site preparation, duct bank installation, cable installation, cable jointing, final testing, and final restoration (described in greater detail in COP Table 3.3.2-2). Installation would generally require excavation of an approximate 6-foot-wide trench within a 25- to 30-foot-wide temporary disturbance corridor; however, the disturbance area at the splice vaults would be 30 feet wide × 70 feet long. The approximately 1-mile-long onshore transmission cable ROW would be maintained free of vegetation that exceeds 15 feet in height.

COP Section 3.3.2 provides design and construction details for the onshore transmission cable. Refer to Section 2.1.2.2.3 for a discussion of onshore segments of the Proposed Action.

As stated in Section 2.1.2.2.3, the onshore transmission cable would be installed within a duct bank, buried to a target depth of 3 to 6 feet to the top of the duct bank, and be consistent with local utility standards. The conduits would be encased in a concrete duct bank and installed in an open trench for most of the Project. Once excavated, the open trench would be supported by a shoring system to allow for installation of the conduits inside the trench. The conduits would be held in place using conduit spacers to allow the concrete to be poured and set between each duct without allowing the formation of any air pockets or voids. This would be repeated until all conduits and concrete have been installed to the specified jointing locations (manholes, termination structures, etc.). At the completion of the installation, all conduits would be proofed and mandreled[9] to verify continuity of the raceway for cable installation. The cable would be pulled through the raceway and cut, leaving a sufficient amount of slack to perform the jointing operations. After pulling, the integrity of each cable jacket would be tested, and the cables would be sealed to prevent moisture ingress until the cables are spliced/jointed. Splicing would occur after all the cables for a specific section have been pulled into the jointing bay or termination section. Two splice vaults per circuit (four total) would be required along the onshore transmission cable route. Each splice vault measures 30 × 8 × 8 feet (see Table 2.1-3). The maximum trench depth for splice vault installation is 16 feet. The entire temporary disturbance corridor would be restored to preconstruction conditions following installation of the onshore transmission cable. Construction of the onshore transmission cable from the transition joint bays at landfall to the OnSS would result in up to 3.1 acres of temporary ground disturbance, with no permanent disturbance anticipated (see Table 2.1-3). Construction of the onshore transmission cable would take approximately 12 months.

Onshore Substation and Interconnection Facility

The maximum area of land disturbance associated with the construction of the OnSS and ICF is depicted in COP Figure 3.3.1-1. Table 2.1-3 and Section 2.1.2.2.3 provide construction and operation disturbance acreage for the OnSS and ICF. Contingency staging and laydown areas also include previously disturbed areas owned by the Quonset Development Corporation; staging and laydown in these areas would not require grading but could require graveling, erosion control, fencing, etc. Temporary disturbances would be associated with temporary work areas and staging and laydown areas. OnSS and ICF equipment and steel support structures would be supported by reinforced concrete foundations on drilled shafts suitable

[9] Mandrels are used to test the integrity of the conduit runs and remove small amounts of debris. Refer to Table 3.3.2-2 of the COP.

for existing soil conditions and coastal storm events and flood events. The maximum depth of disturbance associated with construction of the OnSS and ICF is 60 feet.

Preconstruction activities for the OnSS and ICF would involve surveying (including surveys for munitions, explosives of concern, and unexploded ordnance), staking, and protection of sensitive areas. The work site would also be cleared of vegetation, and temporary erosion controls would be installed and maintained until the site is restored and stabilized. Grading would be required to level the ground in preparation of construction, and disturbed areas outside the OnSS and ICF footprint would be restored. Installation of foundations would require excavation to support construction of stormwater management components and installation of other equipment. Blasting is not expected; however, if required, blasting plans and approvals would be obtained before blasting. All major equipment would be installed upon completion of concrete foundations and cable duct banks. The equipment would be rigged and placed on the concrete foundations, alignment checking would be performed, and anchoring and temporary protection from weather would be applied. The OnSS control center would be tested, and once the upgrades at the Davisville Substation are completed and put into service, the commissioning of the OnSS and ICF would begin.

The OnSS and ICF would include other improvements outside the operational footprint, including driveways and maintained landscaping (up to 7.1 acres for the OnSS and 4.0 acres for the ICF). Once construction is complete, temporary disturbance areas beyond the operational footprint of both the OnSS and ICF would be restored to preconstruction conditions. Construction of the OnSS and ICF would take up to 18 months. Construction of the OnSS and ICF would generate approximately 3,000 cubic yards (cy) of solid waste, which would be disposed of in a landfill and/or recycling center.

2.1.2.4 Operations and Maintenance

The proposed Project is anticipated to have an operating period of 35 years.[10] Revolution Wind would use a variety of vessels to support O&M, including SOVs with deployable work boats (daughter craft[11]), crew transfer vessels, jack-up vessels, and cable laying vessels. To support O&M, the Project would be controlled 24 hours a day/7 days a week via a remote surveillance system (i.e., SCADA). As stated in Section 2.1.2.1.8, Revolution Wind is evaluating five ports (Port of Brooklyn, Port of Davisville at Quonset Point, Port of Galilee, Port Jefferson, and Port of Montauk) to support O&M for the Project.

2.1.2.4.1 Offshore Activities and Facilities

During O&M, Revolution Wind would employ a proprietary state-of-the-art asset management system to inspect offshore transmission assets, including the OSS (electrical components), RWEC, IACs, and OSS-link cable, which would provide a data-driven assessment of the asset condition and would allow for prediction and assessment of whether inspections and/or maintenance activities should be accelerated or

[10] For analysis purposes, BOEM assumes in this EIS that the Project would have an operating period of up to 35 years. Revolution Wind's lease with BOEM (Lease OCS-A 0486) has an operations term of 25 years that commences on the date of COP approval (see 30 CFR 585.235(a)(3)). Revolution Wind would need to request and be granted an extension of its operations term from BOEM, 30 CFR 585.425-585.429, in order to operate the Project for 35 years. Although Revolution Wind has not made such a request, this EIS uses the longer period in order to avoid possibly underestimating any potential effects.

[11] Daughter craft are crafts/vessels (e.g., deployable work boats) that are launched and operated from a mother ship and recovered to it when not operational.

postponed. The RWEC, IACs, and OSS-link cable typically have no maintenance requirements unless a fault or failure occurs.

Cable protection placed during installation could require replacement or remediation over the lifetime of the Project. These maintenance activities are considered non-routine. Additional non-routine maintenance activities would include repair-replacement of portions of the RWEC, IAC, and OSS-link cable. If cable repair or replacement or remedial cable protection is required, Revolution Wind would obtain necessary approvals. These activities would be limited to the disturbance corridors previously defined for construction, as stated in Tables 2.1-1 and 2.1-3. Further details on transmission cable maintenance are outlined in Section 3.5.2 of the COP. Routine transmission cable maintenance and survey activities are applicable to all cable types.

WTGs and the OSS would be maintained and equipped with safety devices and FAA- and USCG-recommended marking and lighting. For planned maintenance activities, personnel access would be provided using crew transfer vessels during low wind periods. Revolution Wind would also conduct annual inspections of blades (internal and external visual inspection), routine service and safety surveys, and oil and high voltage maintenance. Certain O&M activities could require the use of jack-up or crane barges if repairs to equipment such as power transformers, reactors, or switchgear are necessary.

Lighting during O&M for WTGs and OSSs is detailed in Figure 2.1-4 and Figure 2.1-6, respectively. Lighting that would be visible for viewers on the shore (refer to Section 3.19 Visual Resources) would be primarily limited to lighting required under FAA and USCG regulation and would include lighting on OSS signboards and maintenance lighting. Signboard lighting is limited to three low-intensity white lights illuminating each of the four sides of the OSS (see Figure 2.1-6). Maintenance lighting would be in place on WTG and OSS platforms and would be used in the rare instance that maintenance during the night is required and for additional worker safety. These working lights would be diffuse and pointed down toward the platform and would similarly cast little light in other directions.

A summary of offshore transmission facility (e.g., RWEC, IACs, OSS-link cable, and OSS electrical components) routine maintenance and survey activities, including all cable types, and the indicative frequency at which they could occur is provided in COP Table 3.5.2-1.

Each WTG and OSS would contain small amounts of oils, fuels, and lubricants to support operations. Sulfur hexafluoride gas could be used for electrical insulation in some switchgear components, such as on the WTG. Appendix E, Table E4-1 provides a summary of maximum potential quantities of hazardous materials consisting of oils, fuels, lubricants, and sulfur hexafluoride gas per WTG and OSS during operations.

Vessels and Vehicles

O&M of the offshore Project components would require the use of a variety of vessels as well as helicopters (see COP Table 3.5.7-2). Vessels to support O&M would include SOVs with deployable work boats (daughter craft), crew transfer vessels, jack-up vessels, and cable laying vessels. See COP Section 3.3.10.2 for a list of the number of vessel and vehicle trips by various operations-related tasks.

2.1.2.4.2 Onshore Activities and Facilities

Revolution Wind is evaluating five ports to support O&M for the Project. See Section 2.1.2.1.8 and Appendix D for a discussion of the construction plans at those ports.

Revolution Wind would monitor the OnSS remotely on a continuous basis. The ICF would be managed and operated by TNEC. The equipment in the OnSS would also be configured with systems (i.e., SCADA) that would alarm upon detecting equipment problems, unintended shutdowns, or other issues. In addition, the OnSS would be inspected periodically, in accordance with manufacturer recommendations. Revolution Wind would develop an established and documented program for the maintenance of all equipment critical to reliable operation.

Preventive maintenance would be performed on the OnSS, ICF, and line equipment; planned outages would be conducted in accordance with the North American Electric Reliability Corporation/Northeast Power Coordinating Council, Inc. Standard-TOP-003-1; and protective system maintenance would be performed in accordance with the Northeast Power Coordinating Council, Inc. PRC 005-2 standard. ICF equipment would be maintained in accordance with Rhode Island Energy standards. Maintenance would be completed by qualified personnel in accordance with applicable industry standards and good utility practice to provide maximum operating performance and reliability.

Vegetation management would also occur on the OnSS and ICF properties. The landfall work area and onshore transmission cable route would not require vegetative management and would be fully restored once construction is complete. The OnSS would have a 30-foot-wide perimeter around the outside of the OnSS facility fence line that would be maintained, and the ICF would have a 10-foot-wide perimeter around the outside of the ICF fence line that would be maintained. Similarly, the transmission cables connecting the OnSS and the ICF would have a 20-foot ROW centered on the cables, and the transmission circuits connecting the ICF to the Davisville Substation and tap line would have a 120-foot-wide ROW centered on the circuits.

Vehicles

O&M of the onshore Project components would require the use of typical fleet and/or employee vehicles to access the OSS, ICF, ROWs, O&M facility, and port areas where crew transfers would take place. See COP Section 3.3.10.2 for a list of the number of vehicle trips by various construction tasks.

2.1.2.5 Decommissioning

Pursuant to 30 CFR 585, Revolution Wind would be required to remove or decommission all offshore and onshore installations and clear the seafloor of all obstructions created by the Project. If the COP is approved or approved with modifications, Revolution 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. In accordance with applicable regulations and a BOEM-approved decommissioning plan, Revolution Wind would have up to 2 years to decommission the Project following termination of the lease (up to 35 years postconstruction). Decommissioning would return the area to preconstruction conditions, as feasible, barring the replacement of naturally occurring seafloor obstructions such as boulders. All facilities would be removed to a depth of 15 feet below the mudline, unless otherwise authorized by the Bureau of Safety and Environmental Enforcement (30 CFR 285.910(a)).

Revolution Wind would submit a decommissioning application prior to any decommissioning activities and BOEM would conduct a determination of NEPA adequacy at that time, which could result in the preparation of additional NEPA analyses. Revolution Wind would develop a decommissioning plan for the facility that complies with all relevant permitting requirements. This plan would account for changing circumstances during the operational phase of the Project and would reflect new discoveries, particularly in the areas of marine environment, technological change, and any relevant amended legislation.

Future decommissioning may not occur for all Project components; however, for the purposes of this EIS, all analyses assume that decommissioning would occur as described in this section. WTG components and the OSSs would be disconnected and removed using a jack-up lift vessel or a derrick barge. Cables would be removed in accordance with BOEM regulations (30 CFR 585, Subpart I). A material barge would transport components to a recycling yard. The foundations would be cut by an internal abrasive water jet cutting tool at 15 feet below the seafloor and returned to shore for recycling. Revolution Wind would clear the area after all components have been decommissioned to ensure that no unauthorized debris remains on the seafloor. Onshore decommissioning requirements would be subject to state/local authorizations and permits.

2.1.2.6 Environmental Protection Measures and Additional Authorizations

Revolution Wind has committed to environmental protection measures (EPMs) as part of its Project to avoid or minimize impacts to physical, biological, socioeconomic, and cultural resources. These measures are listed in the COP and described in Table F-1 in Appendix F and are analyzed as part of the Proposed Action in the EIS. During the development of the EIS, BOEM considered potential additional mitigation measures that could further avoid, minimize, or mitigate impacts on the physical, biological, socioeconomic, and cultural resources assessed in this EIS. Table F-2 and Table F-3 in Appendix F describe these potential additional mitigation measures, and the subsequent Chapter 3 sections analyze them separately by resource. As noted in Section 1.3, Revolution Wind would also obtain all other necessary state and federal permits and authorizations under applicable statutes prior to Project construction. These other permits and authorizations could include additional measures.

2.1.2.7 Survey and Monitoring Activities

As part of the Proposed Action, Revolution Wind has committed to conducting preconstruction, during construction, and postconstruction surveys and monitoring. Revolution Wind is conducting the surveys and monitoring under existing permits, where appropriate, prior to approval of the COP. These survey and monitoring efforts are included in Table 2.1-14 and in Tables F-1 and F-2 in Appendix F and could be required by BOEM in the ROD.

Table 2.1-14. Revolution Wind Survey Monitoring Activities

Survey Type	Location	Status/Time Frame	Duration	General Notes
Trawl survey (asymmetrical before-and-after-control-impact [BACI] survey)	RWF and nearby reference areas	Preconstruction: To begin in winter 2021, during construction, and postconstruction	2 years of preconstruction sampling, to continue during construction, and a minimum of 2 years of postconstruction monitoring	Using a Northeast Area Monitoring and Assessment Program survey trawl net towed on the bottom behind vessel and carried out on a seasonal basis, with four surveys planned a year
RWF ventless trap survey - lobsters and crabs (asymmetrical BACI survey, gradient survey)	RWF and nearby reference areas	Preconstruction: To begin May or June of 2022, during construction, and postconstruction	2 years of preconstruction sampling, to continue during construction, and a minimum of 2 years of postconstruction monitoring	BACI survey: Using weak-link buoy lines (< 1,700-pound breaking strength) that are recommended by NMFS with sinking groundline between pots Postconstruction gradient survey: Using only ventless traps for monitoring
Acoustic telemetry - highly migratory species	RWF and adjacent Orsted lease sites	Preconstruction: Started in July 2020, during construction, and postconstruction	July 2020 through 2026	Researchers will use VR2AR acoustic release receivers; no vertical lines in the water for the acoustic receivers to mitigate entanglement risk. Receivers will have a low vertical profile (< 6 feet) off the bottom. Receiver array to be expanded in spring or summer of 2022
State water ventless trap survey - export cable (before-after-gradient design)	RWEC route in Rhode Island state waters	Preconstruction, during construction, and postconstruction	2 years of preconstruction sampling, to continue during construction, and a minimum of 2 years of postconstruction monitoring	Sampling to occur twice a month, all 12 months of the year. Using six-pot trawls laid parallel to the cable; includes acoustic receivers attached to lobster pots

Survey Type	Location	Status/Time Frame	Duration	General Notes
Benthic monitoring - hard and soft bottom	RWF and RWEC	Preconstruction and postconstruction	Hard bottom monitoring 12 months prior to construction and 1 month after seafloor preparation, with postconstruction monitoring at intervals of 1, 2, 3, and 5 years Soft bottom monitoring 6 months prior to seafloor preparation and subsequent surveys at 1 year intervals for 3 years and 5 years postconstruction	Hard bottom monitoring will use remotely operated vehicle video and audio collection, with multibeam echosounder and side-scan sonar surveys to map hard bottom habitat. Soft bottom monitoring will use sediment profile and plan view imaging field data collection.

Sources: Roll (2021); VHB (2023).

2.1.3 Alternative C: Habitat Alternative

Alternative C (Habitat Impact Minimization Alternative [Habitat Alternative]) would comprise the construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the RWF COP. In order to reduce impacts to complex habitats that support commercial and recreational fisheries species such as Atlantic cod (i.e., spawning adults) from the Proposed Action, certain WTG positions would be omitted while maintaining a uniform east-west and north-south grid of 1 × 1–nm spacing between WTGs (Figures 2.1-10 and 2.1-11). The placement of WTGs would be supported by location-specific benthic and habitat characterizations. Under this alternative, fewer WTG locations (and potentially fewer miles of IACs) than proposed by Revolution Wind would be approved by BOEM. Under this alternative, BOEM could select one of the alternatives in Table 2.1-15.

Table 2.1-15. Alternative C Alternatives

Alternative	Descriptions
C1	This alternative allows for the fulfillment of the existing three PPAs, which total 704 MW, while omitting WTGs in locations to maintain a uniform east-west and north-south grid of 1 × 1–nm grid spacing between WTGs. Under this alternative, up to 65 WTGs would be approved.
C2	This alternative allows for the fulfillment of the existing three PPAs, which total 704 MW, while omitting WTGs in locations to maintain a uniform east-west and north-south grid of 1 × 1–nm grid spacing between WTGs. Under this alternative, up to 64 WTGs would be approved.

For both Alternatives C1 and C2, the largest-capacity WTG in the PDE was assumed (12 MW), in which case, the number of WTG positions remaining would provide at least five “spare” WTG locations to allow for flexibility during installation.

Alternative C1 reduces development in areas of contiguous complex habitat slightly more than Alternative C2. Alternative C2 shifts exclusion of three WTG positions from the southeastern portion to areas further north to reduce development in or adjacent to known cod spawning areas, however, resulting in slightly less complex habitat avoided when compared to Alternative C1. See Section 3.6.2.4 for more information on differences in impacts to complex habitats. BOEM, in coordination with NMFS, considered a total of four alternatives to Alternative C prior to narrowing the selection to the two alternatives illustrated in Figures 2.1-11 and 2.1-12. Appendix K provides additional rationale on the evolution of Alternatives C1 and C2.[12]

[12] BOEM received information from the Project proponent indicating that there were technical difficulties associated with installing turbines at 21 of the positions and that some of these positions would be needed to fully implement Alternatives C, D, and E. BOEM independently evaluated this information and that information was part of the basis of developing Alternative G.

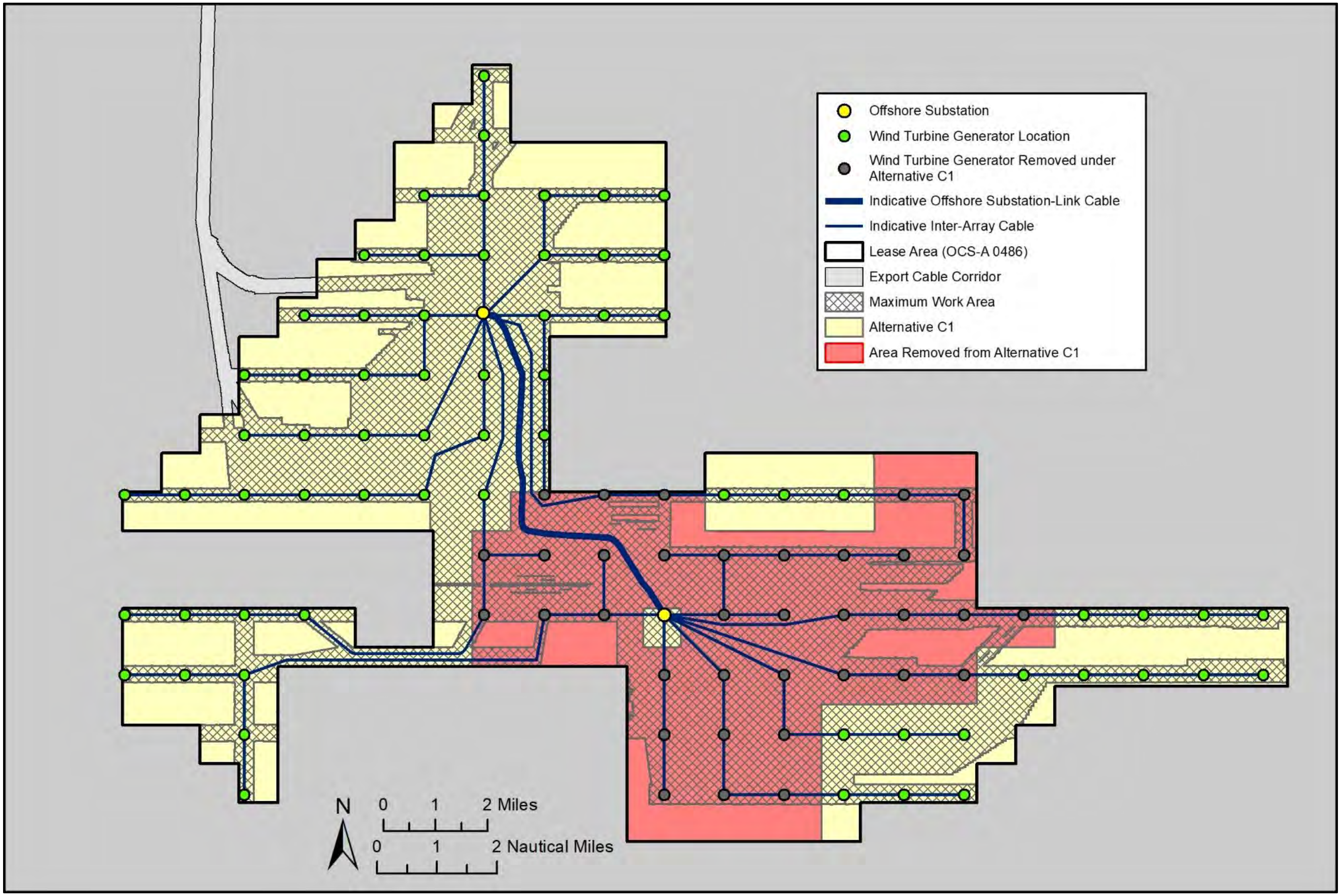


Figure 2.1-11. Project location and components under the Alternative C1.

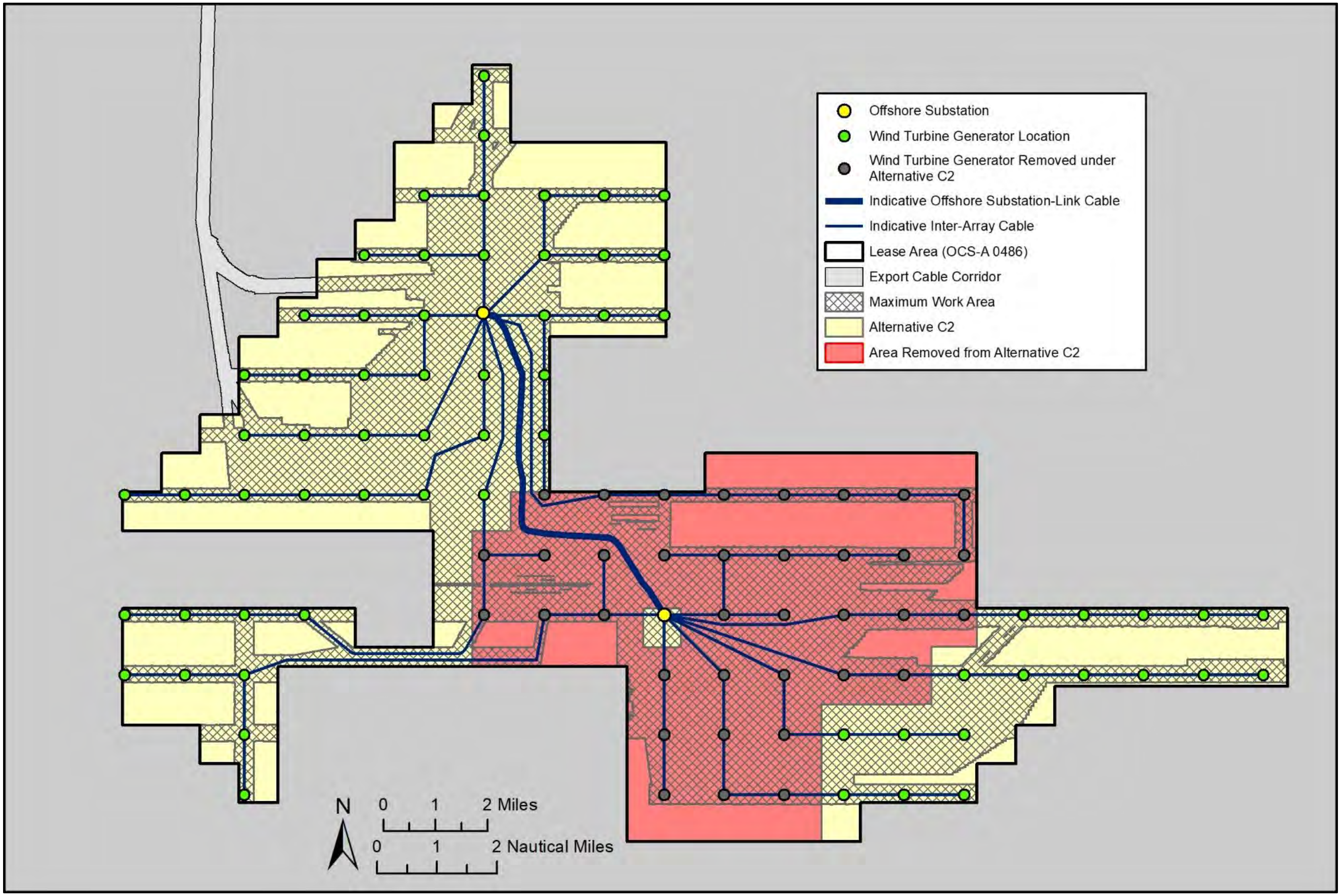


Figure 2.1-12. Project location and components under the Alternative C2.

2.1.4 Alternative D: Transit Alternative

Alternative D (No Surface Occupancy in One or More Outermost Portions of the Project Area Alternative [Transit Alternative]) would comprise the construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the RWF COP. However, to reduce navigation risks and conflicts with other competing space uses, WTGs adjacent to the Buzzard's Bay Traffic Separation Scheme Inbound Lane or overlapping transit lanes proposed by stakeholders, and areas of Cox Ledge, would be eliminated while maintaining the uniform east-west and north-south 1 × 1–nm grid spacing between WTGs (Figures 2.1-13, 2.1-14, and 2.1-15). Under this alternative, fewer WTG locations (and probably fewer miles of IACs) than proposed by Revolution Wind would be approved by BOEM while still allowing for the fulfillment of existing PPAs up to the maximum capacity identified in the PDE (i.e., 880 MW). Under this alternative, BOEM could select one of the alternatives in Table 2.1-16.

Table 2.1-16. Alternative D Alternatives

Alternative	Descriptions
D1	Removal of the southernmost row of WTGs, which overlap the 4-nm east-west transit lane proposed by the Responsible Offshore Development Alliance (RODA)[13] (Figure 2.1-13). Selecting this alternative would remove up to seven WTGs and associated IACs from consideration while maintaining the east-west and north-south 1 × 1–nm grid spacing.
D2	Removal of the eight easternmost WTGs, which overlap the 4-nm north-south transit lane proposed by RODA (Figure 2.1-14). Selecting this alternative would remove up to eight WTGs and associated IACs from consideration while maintaining the east-west and north-south 1 × 1–nm grid spacing.
D3	Removal of the northwest row of WTGs adjacent to the Buzzard's Bay Traffic Separation Scheme Inbound Lane (i.e., traffic separation scheme; Figure 2.1-15). Selecting this alternative would remove up to seven WTGs and associated IACs while maintaining the east-west and north-south 1 × 1–nm grid spacing.

The seven possible combinations of the three alternatives to Alternative D that are analyzed in this EIS are listed in Table 2.1-17 and are illustrated in Figures 2.1-13 through 2.1-19.

Table 2.1-17. Alternative D Alternatives Combinations

Alternative Combinations	Descriptions
D1	Removal of up to seven WTGs and associated IACs
D2	Removal of up to eight WTGs and associated IACs
D3	Removal of up to seven WTGs and associated IACs
D1+D2	Removal of up to 15 WTGs and associated IACs

[13] On January 3, 2020, RODA submitted a proposed layout to the USCG, BOEM, and NMFS for analysis of its relative impacts to safety and the human environment under NEPA for the New England Wind Energy Area Lease Block (which includes the RI/MA WEA and MA WEA) (Hawkins 2020). The proposed layout includes six transit lanes at least 4-nm wide overlaid onto the 1 × 1–nm grid.

Alternative Combinations	Descriptions
D1+D3	Removal of up to 14 WTGs and associated IACs
D2+D3	Removal of up to 15 WTGs and the associated IACs
D1+D2+D3	Removal of up to 22 WTGs and associated IACs

The selection of all three alternatives (i.e., Alternative D1+D2+D3) would eliminate a total of 22 WTG locations while maintaining the 1 × 1–nm grid spacing proposed in the COP and as described under the Proposed Action. Based on the design parameters outlined in the COP, allowing for the placement of up to 78 WTGs and two OSSs would maintain some flexibility for siting while still allowing for the fulfillment of existing PPAs up to the maximum capacity identified in the PDE (e.g., 880 MW = 74 WTGs needed if 12-MW WTGs are used, providing up to six “spare” WTG locations for siting flexibility).

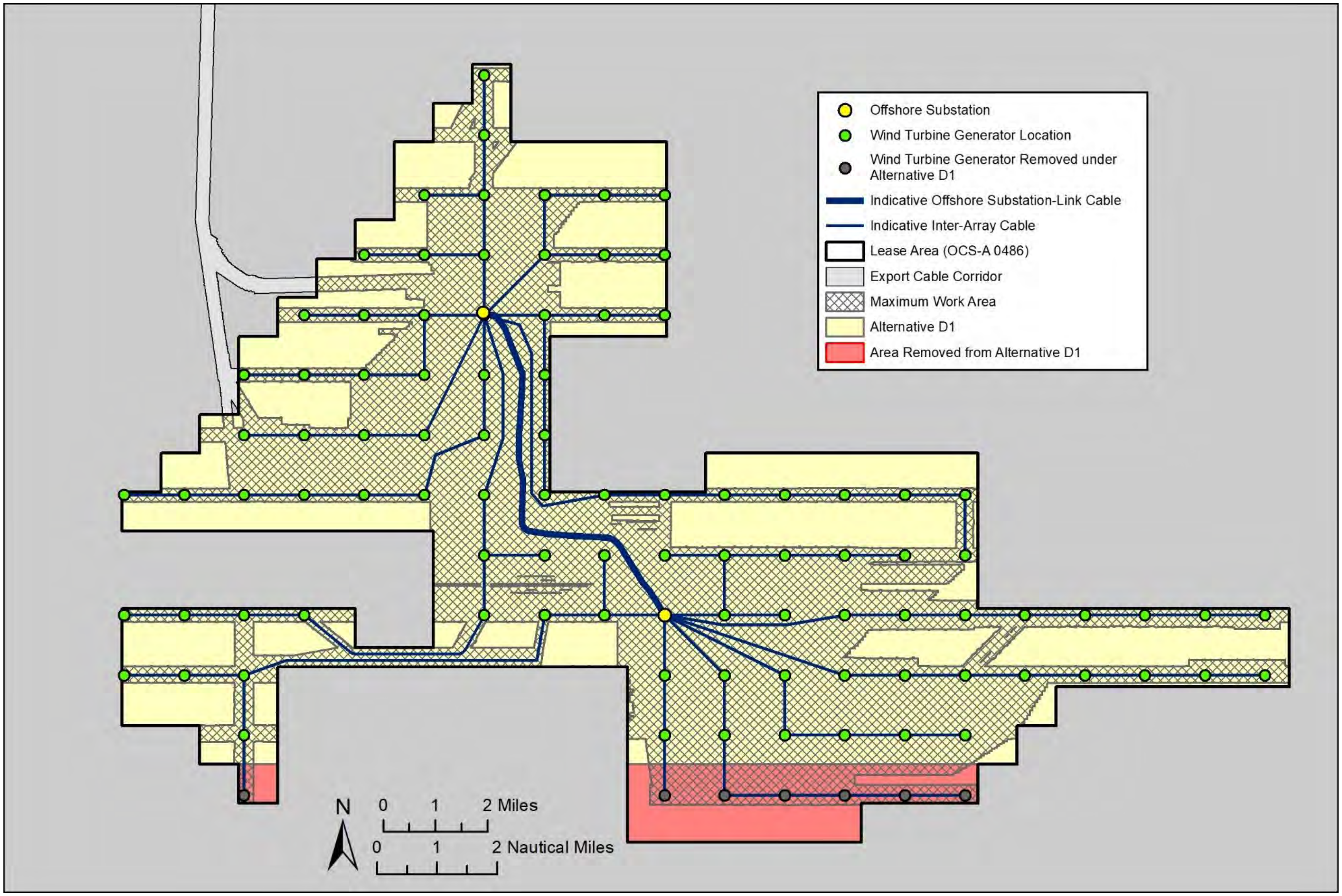


Figure 2.1-13. Project location and components under the Alternative D1.

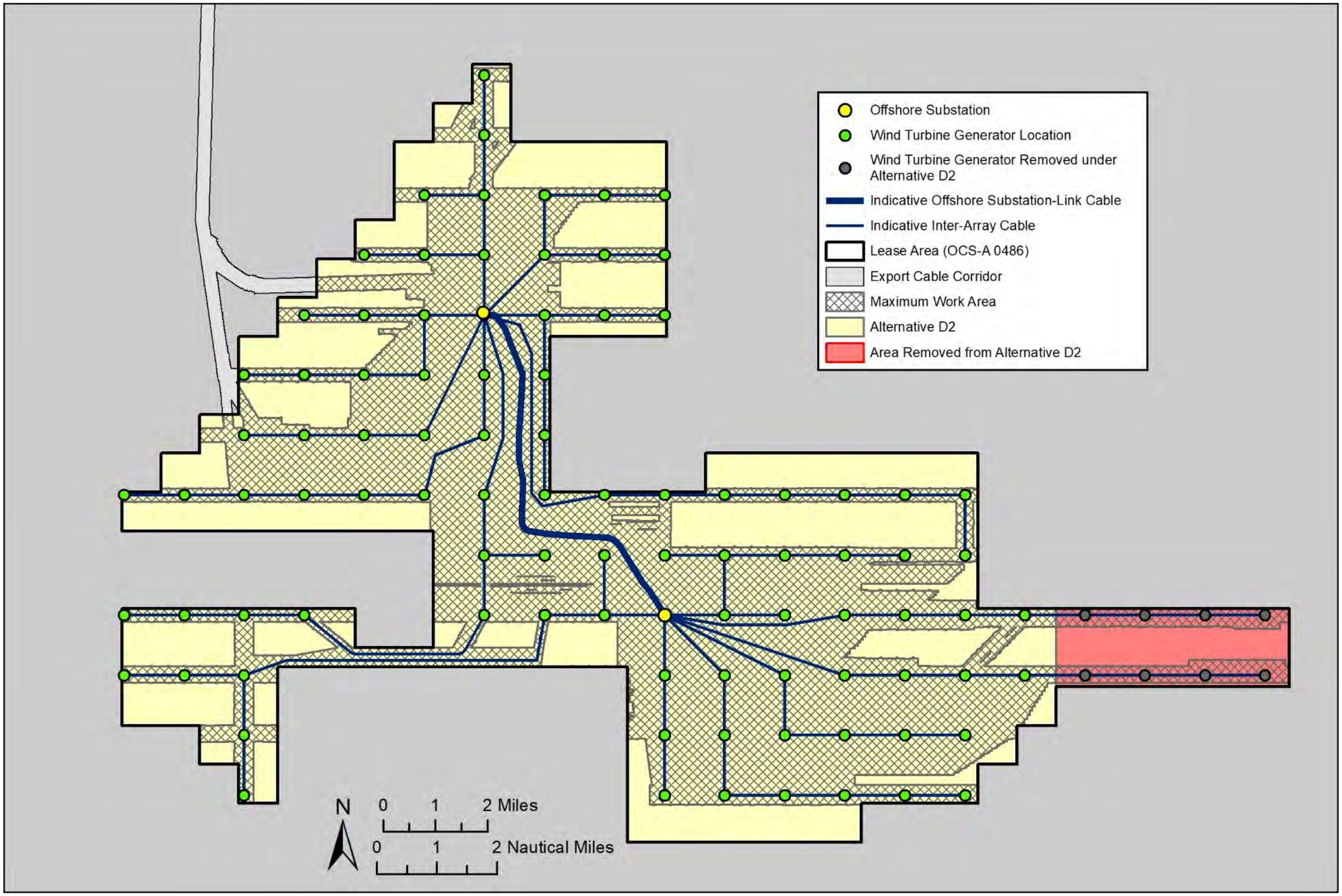


Figure 2.1-14. Project location and components under the Alternative D2.

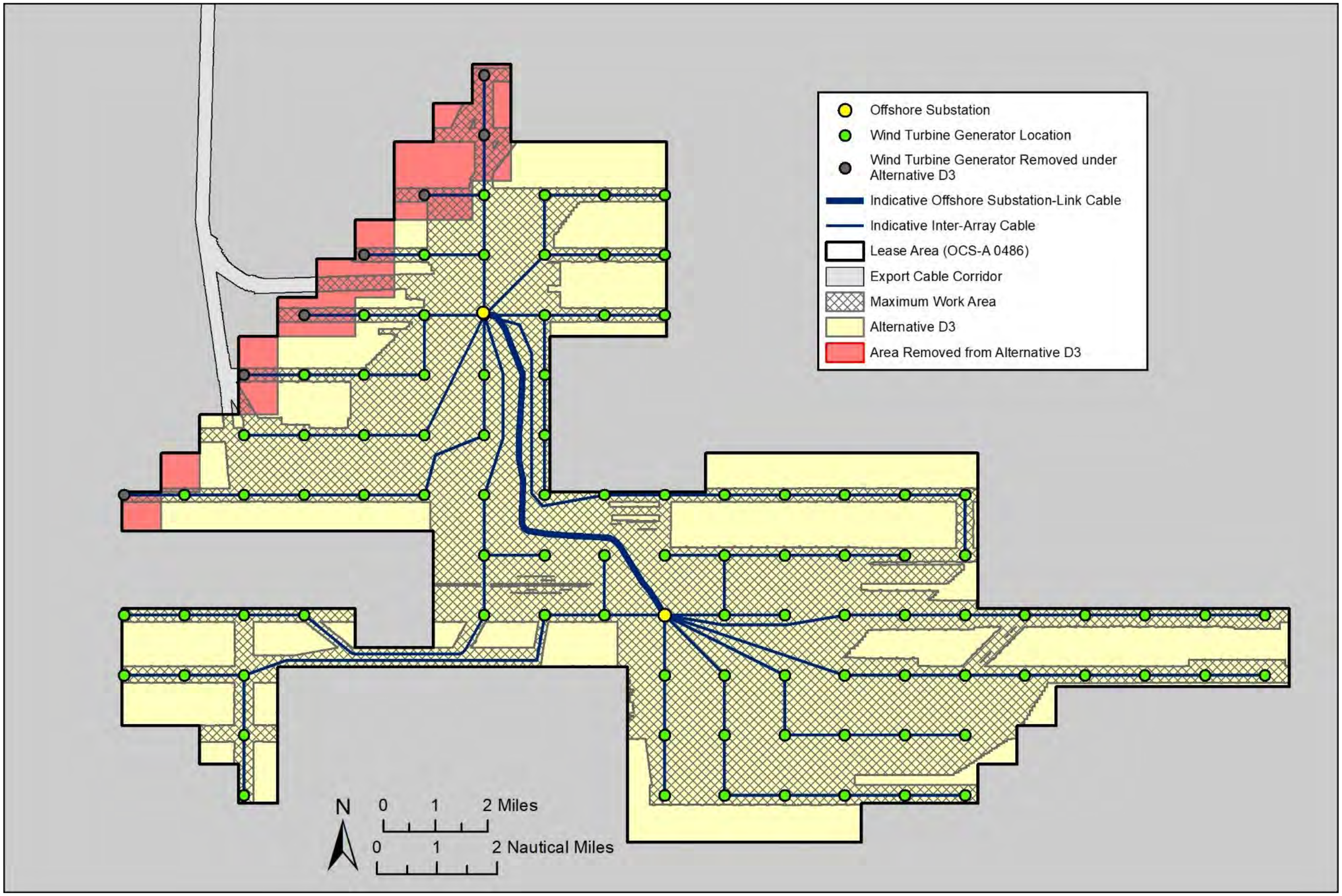


Figure 2.1-15. Project location and components under the Alternative D3.

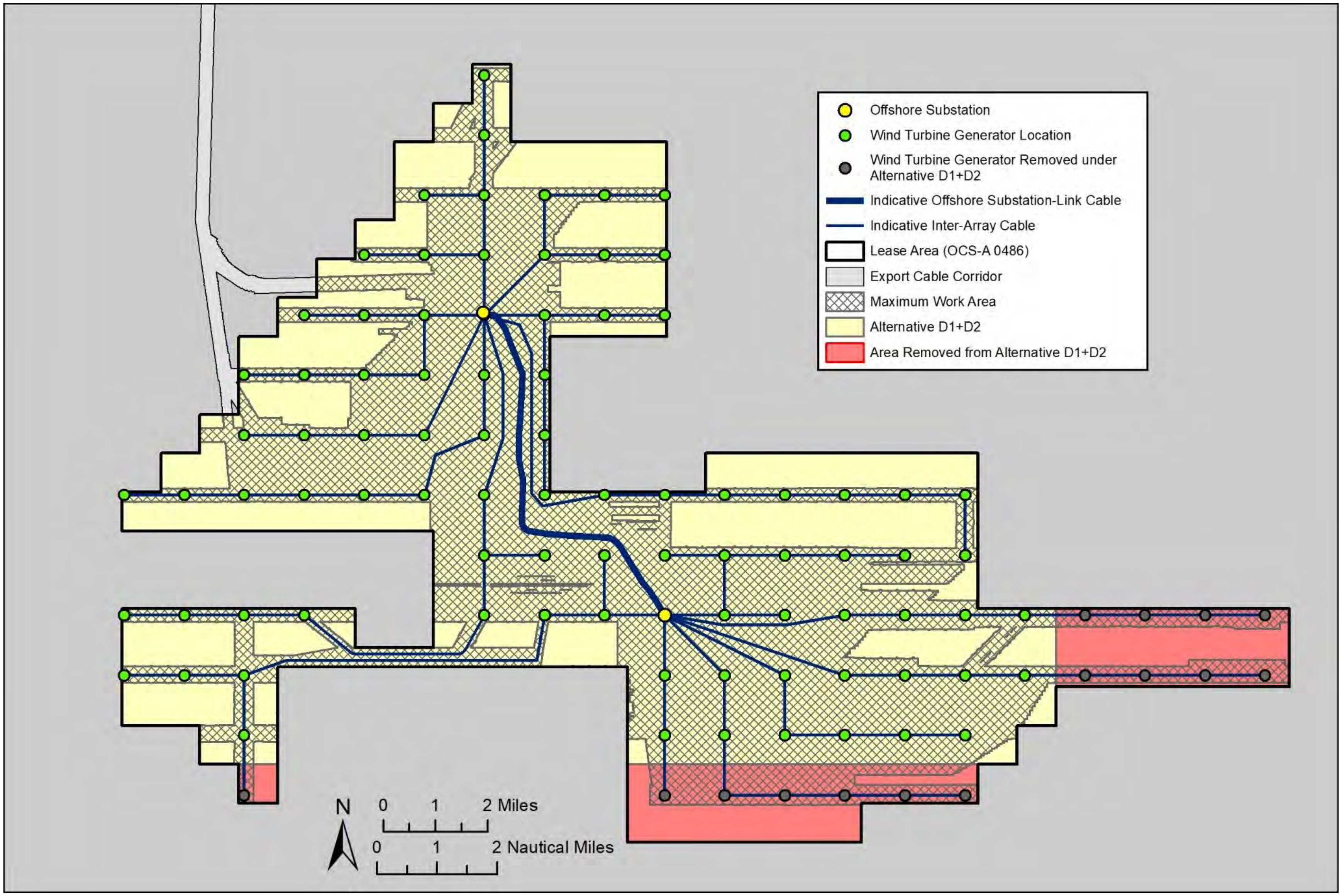


Figure 2.1-16. Project location and components under the Alternative D1+D2.

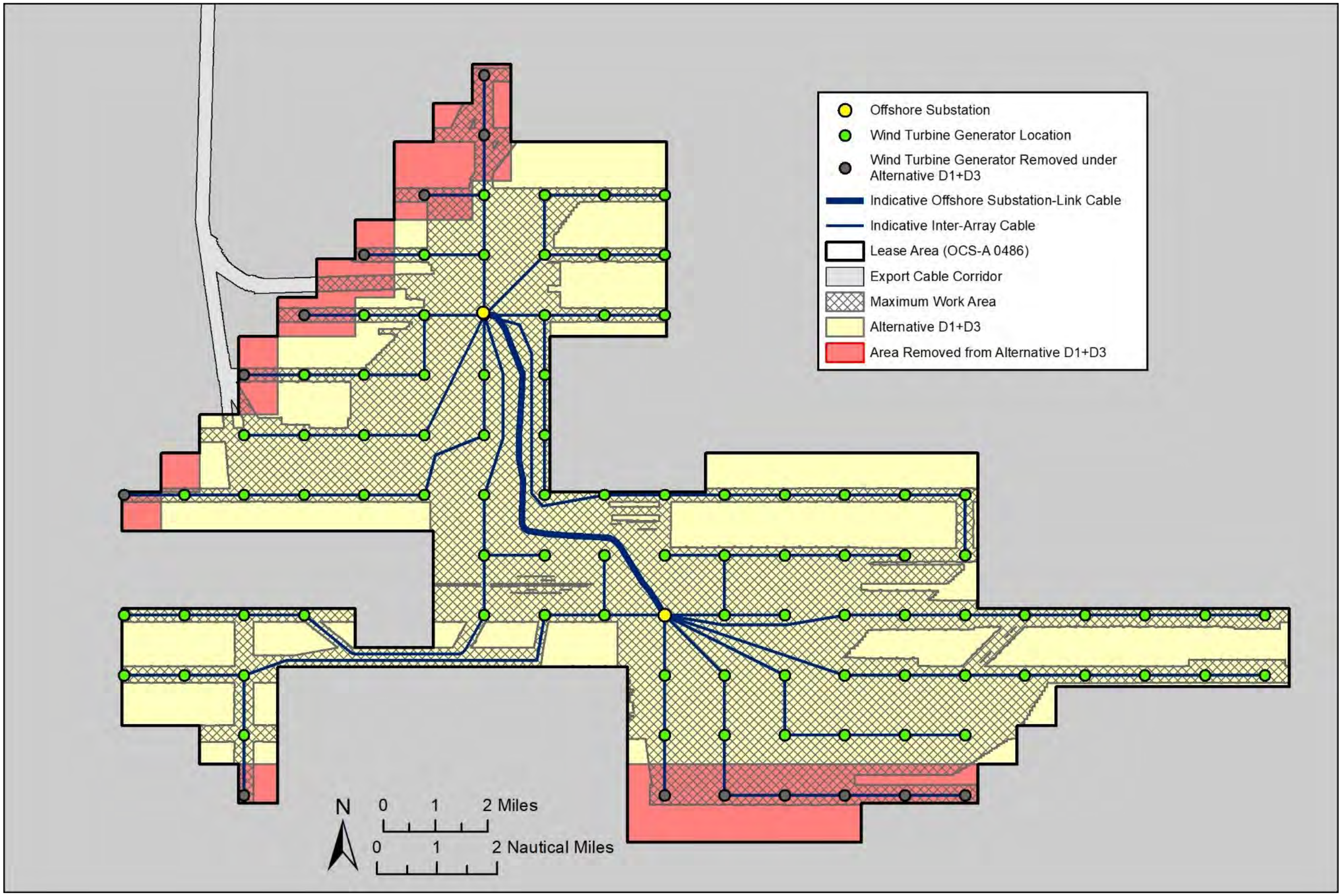


Figure 2.1-17. Project location and components under the Alternative D1+D3.

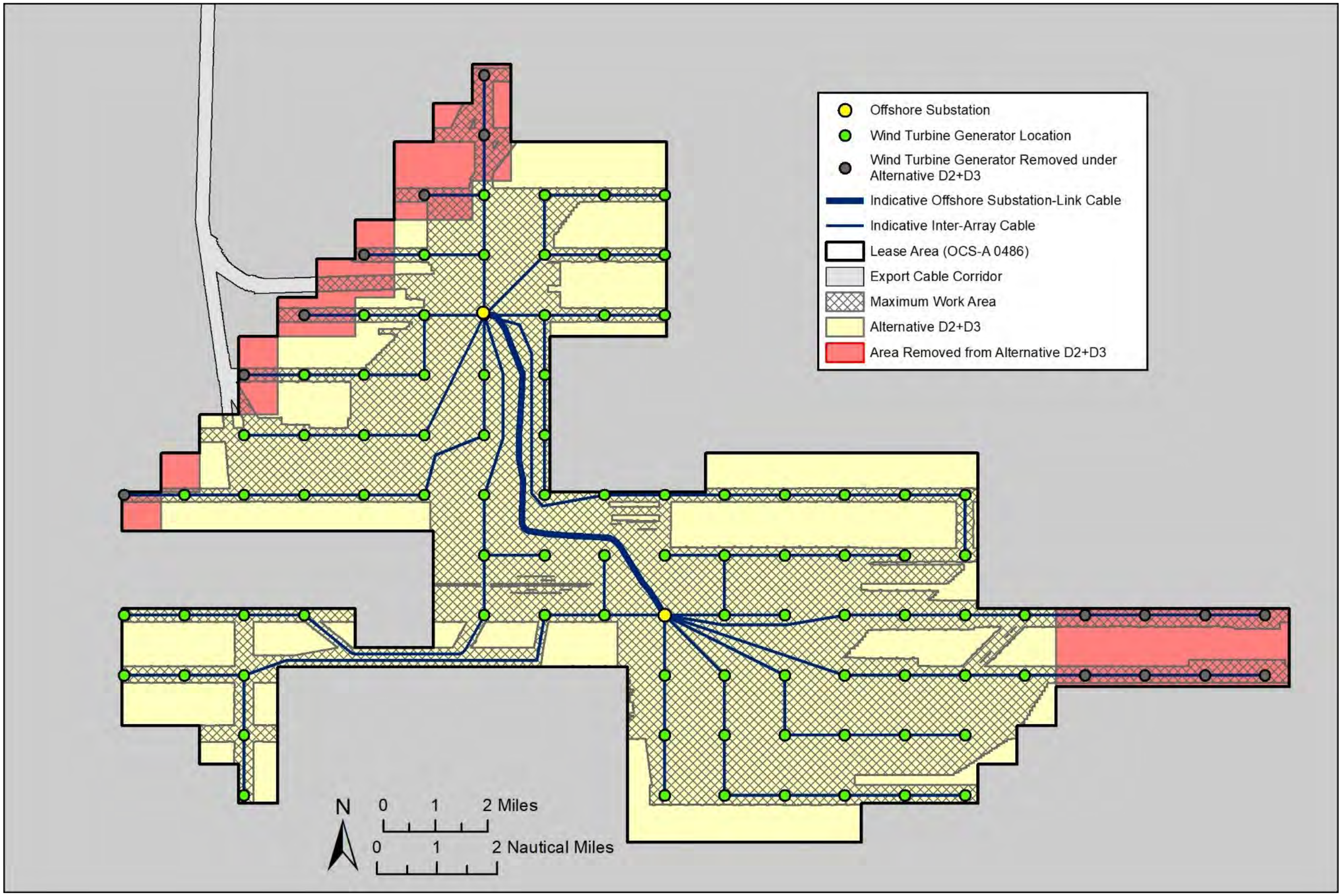


Figure 2.1-18. Project location and components under the Alternative D2+D3.

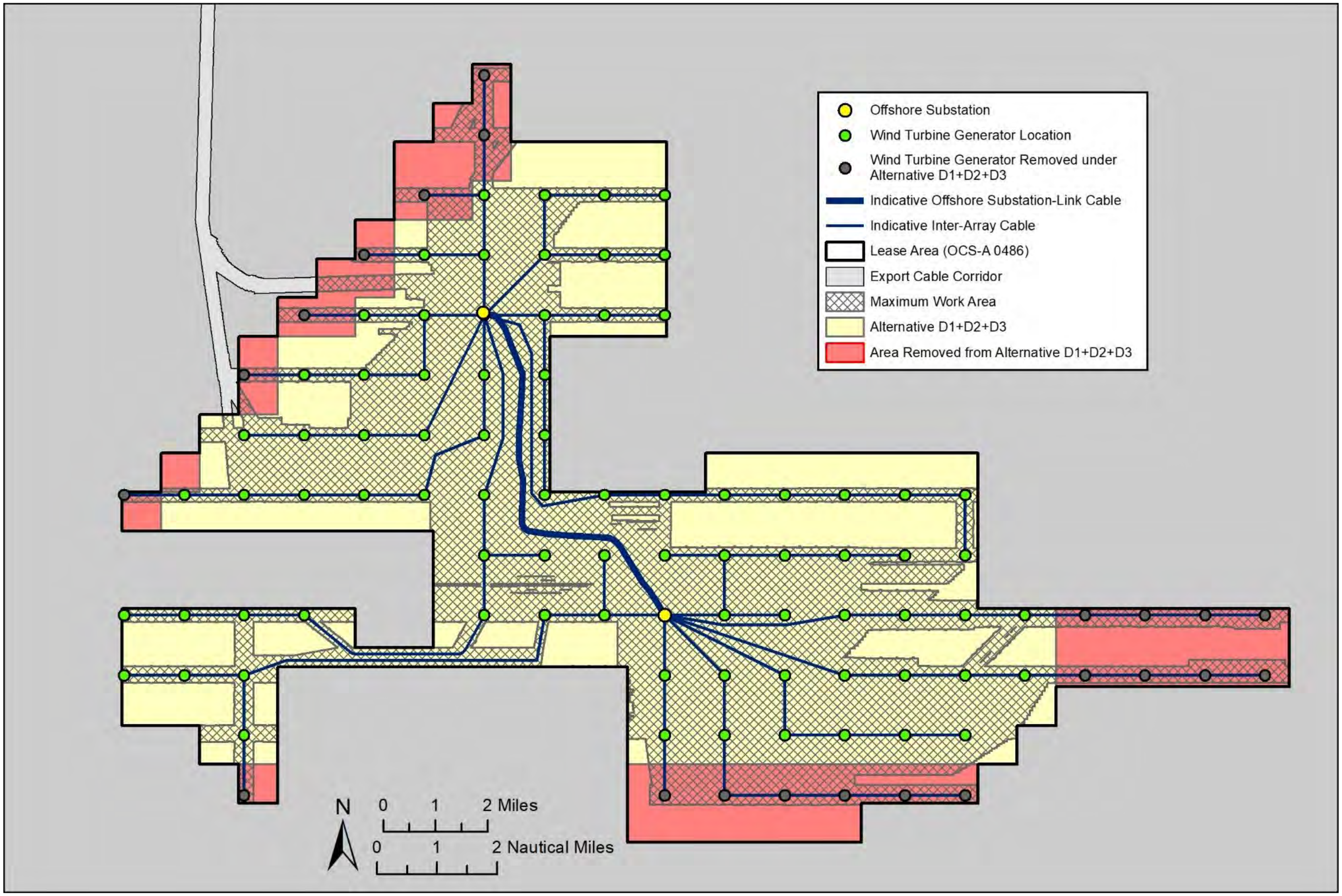


Figure 2.1-19. Project location and components under the Alternative D1+D2+D3.

2.1.5 Alternative E: Viewshed Alternative

Alternative E (Reduction of Surface Occupancy to Reduce Impacts to Culturally-Significant Resources Alternative [Viewshed Alternative]) would comprise the construction and installation, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs, as described in the RWF COP. However, to reduce the visual impacts on culturally important resources on Martha's Vineyard (and likely several other National Historic Landmarks (NHLs) in Rhode Island and Massachusetts), some WTGs would be eliminated while maintaining the uniform east-west and north-south 1 × 1–nm grid spacing between WTGs (Figures 2.1-20 and 2.1-21). Under this alternative, fewer WTG locations (and probably fewer miles of IACs) than proposed by Revolution Wind would be approved by BOEM. Under this alternative, BOEM could select one of the alternatives in Table 2.1-18.

Table 2.1-18. Alternative E Alternatives

Alternative	Descriptions
E1	Allows for the fulfillment of the existing three PPAs, for a total of 704 MW, while eliminating WTG locations to reduce visual impacts to culturally important viewsheds and resources. Under this alternative, up to 64 WTG positions would be approved.*
E2	Allows for a power output delivery identified in the PDE of up to 880 MW, while eliminating WTG locations to reduce visual impacts to culturally important viewsheds and resources. Under this alternative, up to 81 WTG positions would be approved.

* For Alternative E1, the range of WTGs only allows for the selection of an 11-MW or greater capacity WTG to achieve 704-MW output. Assuming the use of the largest-capacity turbine within the PDE would allow for up to five "spare" locations, while no spare positions would be available if an 11-MW turbine is used.

BOEM considered seven alternatives for Alternative E before selecting Alternatives E1 and E2, which are illustrated in Figures 2.1-20 and 2.1-21. Appendix K provides additional rationale on the evolution of Alternative E1 and E2.

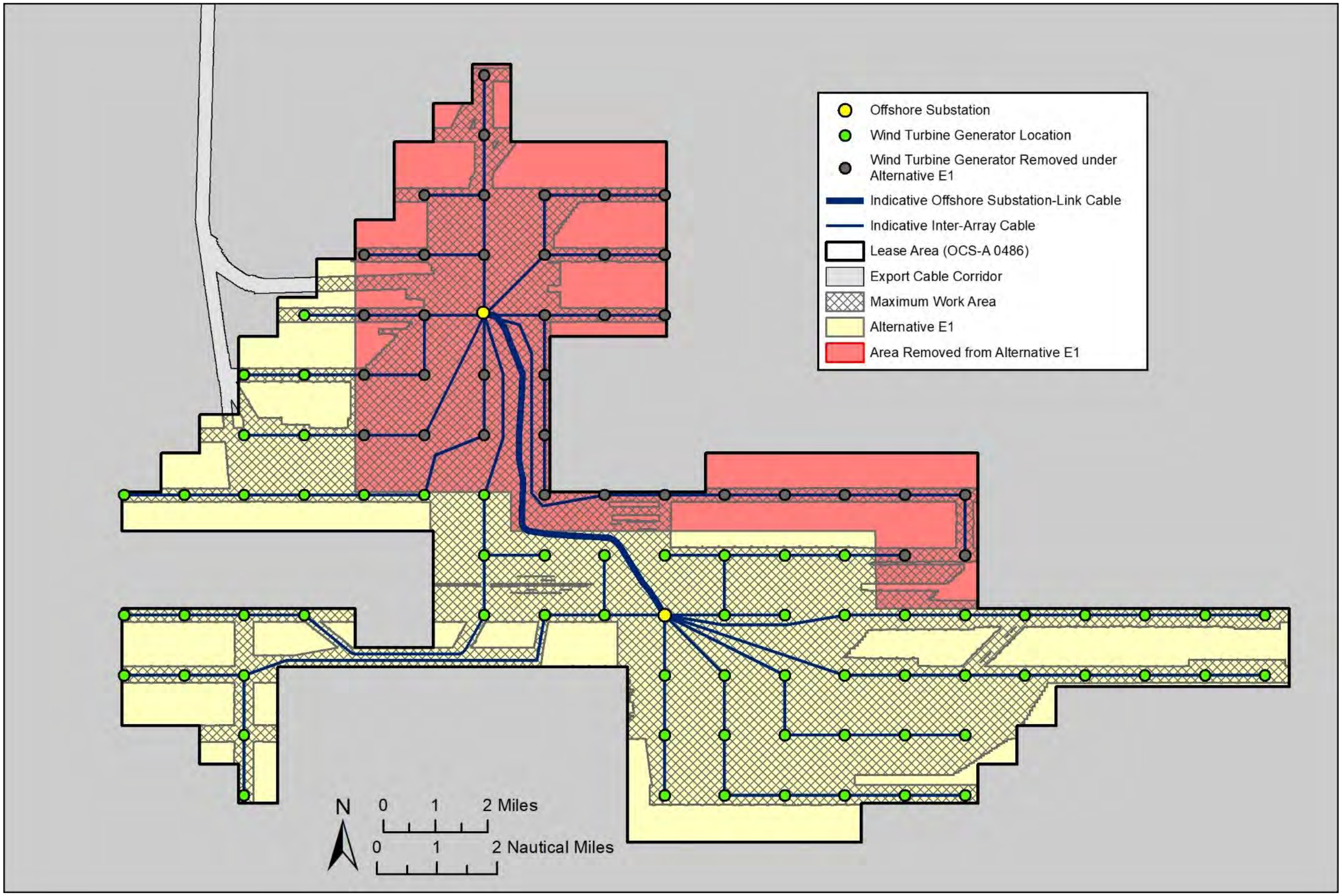


Figure 2.1-20. Project location and components under the Alternative E1.

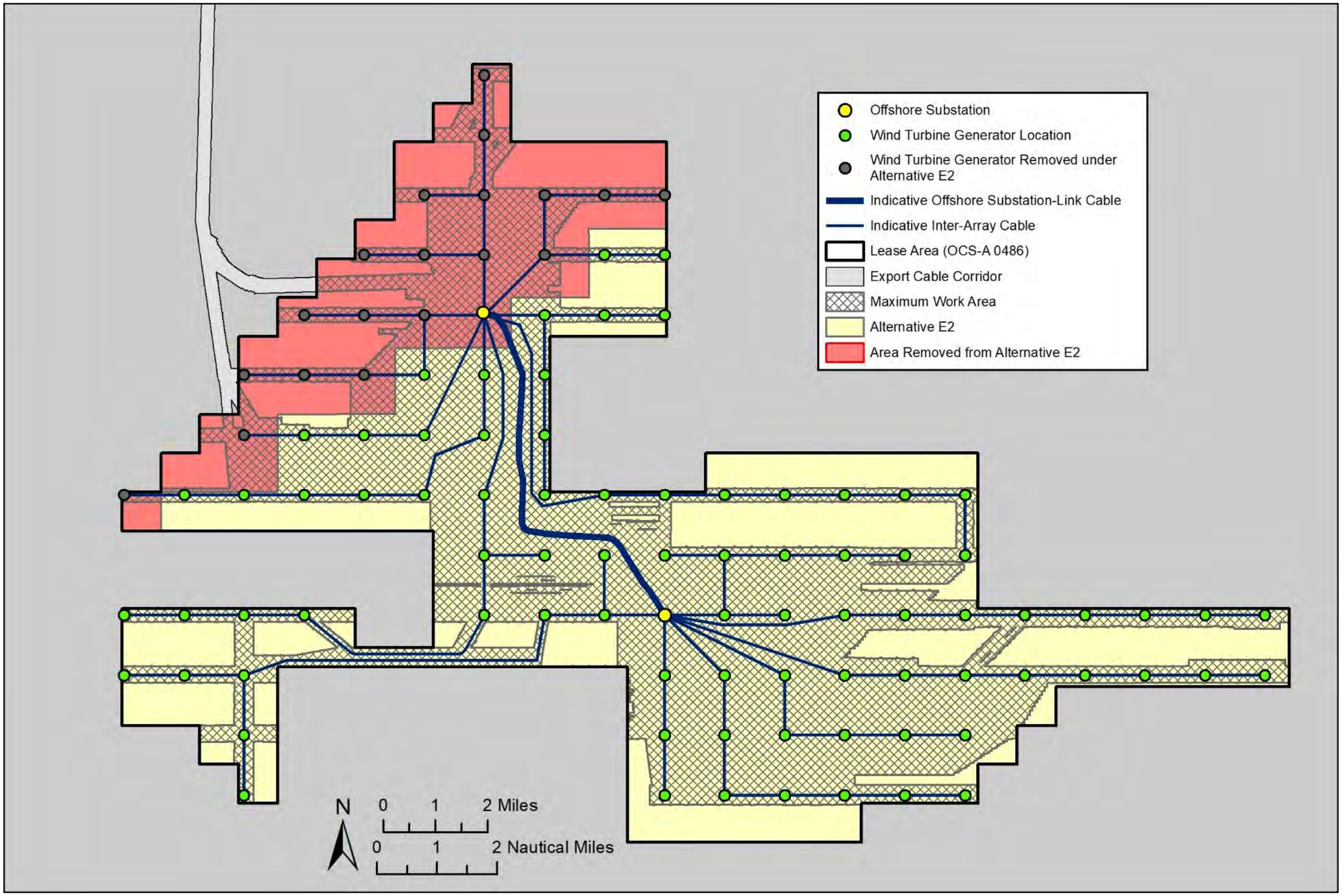


Figure 2.1-21. Project location and components under the Alternative E2.

2.1.6 Alternative F: Higher Capacity Turbine Alternative

Alternative F (Selection of a Higher Capacity Wind Turbine Generator [Higher Capacity Turbine Alternative]) would comprise the construction and installation, O&M, and eventual decommissioning of a wind energy facility implementing a higher nameplate capacity WTG (up to 14 MW assumed for the analysis) than what is proposed in the COP (i.e., the Proposed Action). Key assumptions for bounding this alternative include 1) the higher capacity WTG would fall within the physical design parameters of the PDE and 2) be commercially available to the Project proponent within the time frame for the construction and installation schedule proposed in the COP. BOEM did not identify any potential commercially viable turbines of a capacity higher than 14 MW that meet both criteria (see Appendix K for feasibility analysis).

The number of WTG locations under this alternative would be sufficient to fulfill the minimum existing PPAs (total of 704 MW and 56 WTGs with five “spare” WTG locations included). Using a higher capacity WTG would reduce the number of foundations constructed to meet the purpose and need and thereby potentially reduce impacts to marine habitats and culturally significant resources and potentially reduce navigation risks. Under this alternative, BOEM could select the implementation of a higher capacity turbine in combination with any one alternative or a combination of the alternatives retained for detailed analysis in this EIS. Refer to Section 2.1.2, Section 2.1.3, Section 2.1.4, and Section 2.1.5 for figures.

2.1.7 Alternative G: Habitat and Viewshed Minimization Hybrid Alternative (Preferred Alternative)

Alternative G (Habitat and Viewshed Minimization Hybrid Alternative), also referred to as the Preferred Alternative, would comprise the construction and installation, O&M, and eventual decommissioning of a wind energy facility. The facility would include 65 WTGs with a 8- to 12-MW nameplate capacity that would be located within 79 WTG possible positions (Figure 2.1-22). Alternative G is a hybrid alternative combining elements of Alternatives C, D, and E. Alternative G allows for the fulfillment of the existing PPAs (total of 704 MW), while eliminating certain WTG locations to reduce impacts to complex habitats, areas of high vessel use, and important viewsheds. Alternative G consists of 21 fewer WTG positions and 35 fewer installed WTGs than the Proposed Action, and maintains an east-west and north-south grid of 1 × 1–nm spacing between WTGs.[14] All applicable EPMs, including micrositing of foundations and cables, would apply as described in the COP.

Two of the 65 WTGs have the flexibility to be located in three different spots within the 79 WTG possible positions (see Figure 2.1-22). As a result, this alternative includes the analysis of three layouts for installation of the 65 WTGs as described below and shown in Figure 2.1-23, Figure 2.1-24, and Figure 2.1-25. This flexibility in design could allow for further refinement for visual resources impact reduction on Martha’s Vineyard and Rhode Island, or for habitat impact reduction in the NMFS Priority 1 area. Additionally, 14 of the 79 WTG positions are “spares” and would only be constructed on a case-by-case basis to accommodate unforeseen siting conditions that render any of the 65 WTG installations impractical in terms of technical feasibility or due to environmental impact or safety concerns (i.e., one of

[14] In accordance with 30 CFR 585.634(C)(6), micrositing of WTG foundations may occur within 500 feet of each proposed WTG location. Micrositing of WTGs would be performed on a case-by-case basis to avoid significant seabed hazards such as surface and subsurface boulders (see COP Section 2.2.1.1).

the 65 WTGs could be installed in a “spare” location). Under this alternative, BOEM could select one of the alternatives in Table 2.1-19.

Table 2.1-19. Alternative G Alternatives

Alternative	Descriptions
G1	Allows for the fulfillment of the existing three PPAs totaling 704 MW, while eliminating two WTG locations in the NMFS Priority 1 area to reduce fishery and EFH impacts. Under this alternative, 65 WTGs installed in the positions identified in Alternative G1 would be approved.
G2	Allows for the fulfillment of the existing three PPAs totaling 704 MW, while eliminating two WTG locations to reduce visual impacts on the horizon from the Aquinnah Overlook, a culturally important resource. Under this alternative, up to 65 WTGs installed in the positions identified in Alternative G2 would be approved.
G3	Allows for the fulfillment of the existing three PPAs totaling 704 MW, while eliminating two WTG locations closest to the shore to reduce visual impacts on these culturally important resources. Under this alternative, up to 65 WTGs installed in the positions identified in Alternative G3 would be approved.

Design details, dimensions, and footprints specific to Alternative G are included in Table 2.1-20 All other components of the Project not listed in Table 2.1-20 remain the same for Alternative G as they are for the Proposed Action (see Tables 2.1-3 through 2.1-13). Appendix K provides a feasibility analysis of all alternatives and additional rationale on the evolution of Alternatives G1, G2, and G3. Micrositing of foundations and cables is anticipated during installation for all action alternatives analyzed in this EIS, including Alternatives G1, G2, and G3.

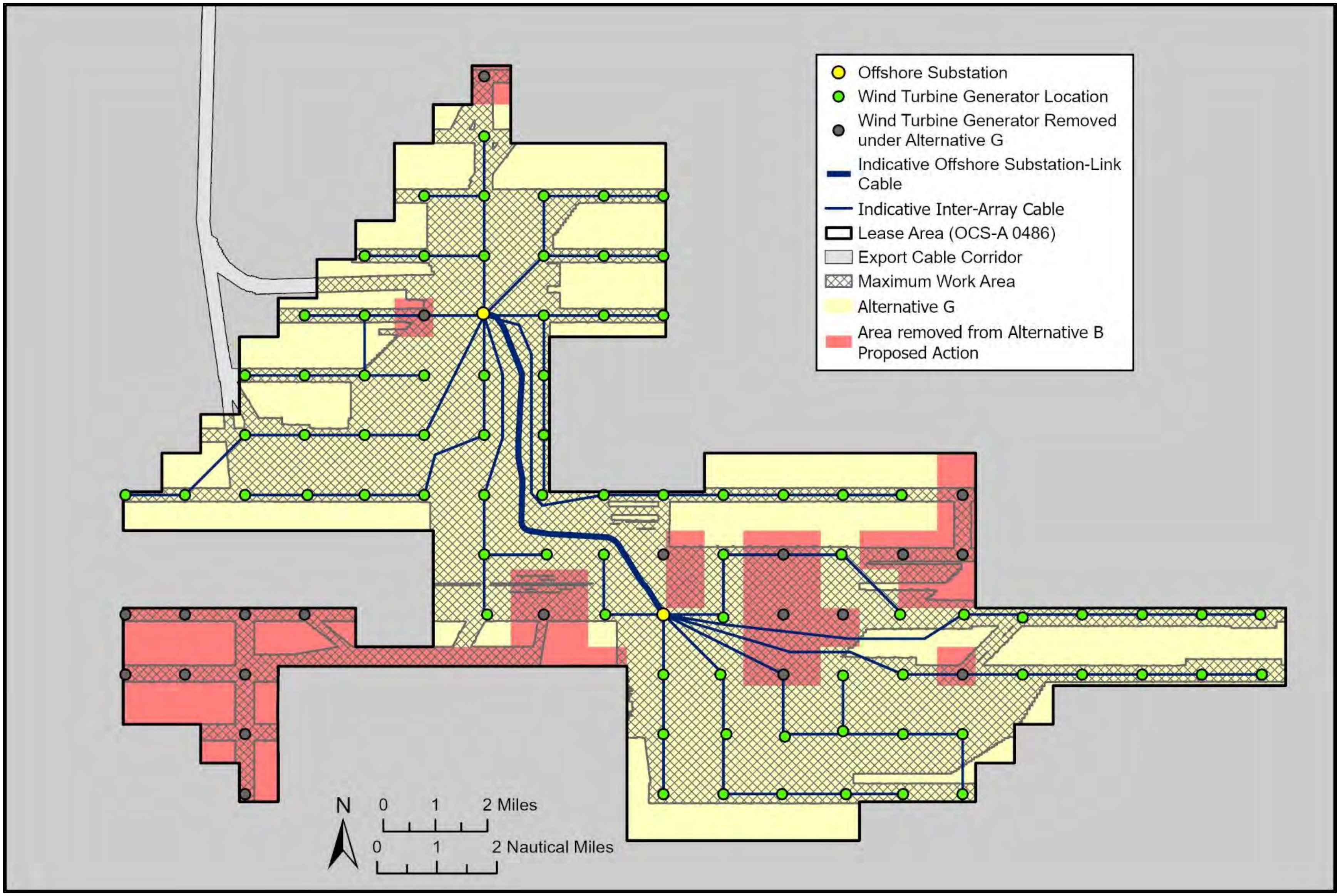


Figure 2.1-22. Project location and components under Alternative G.

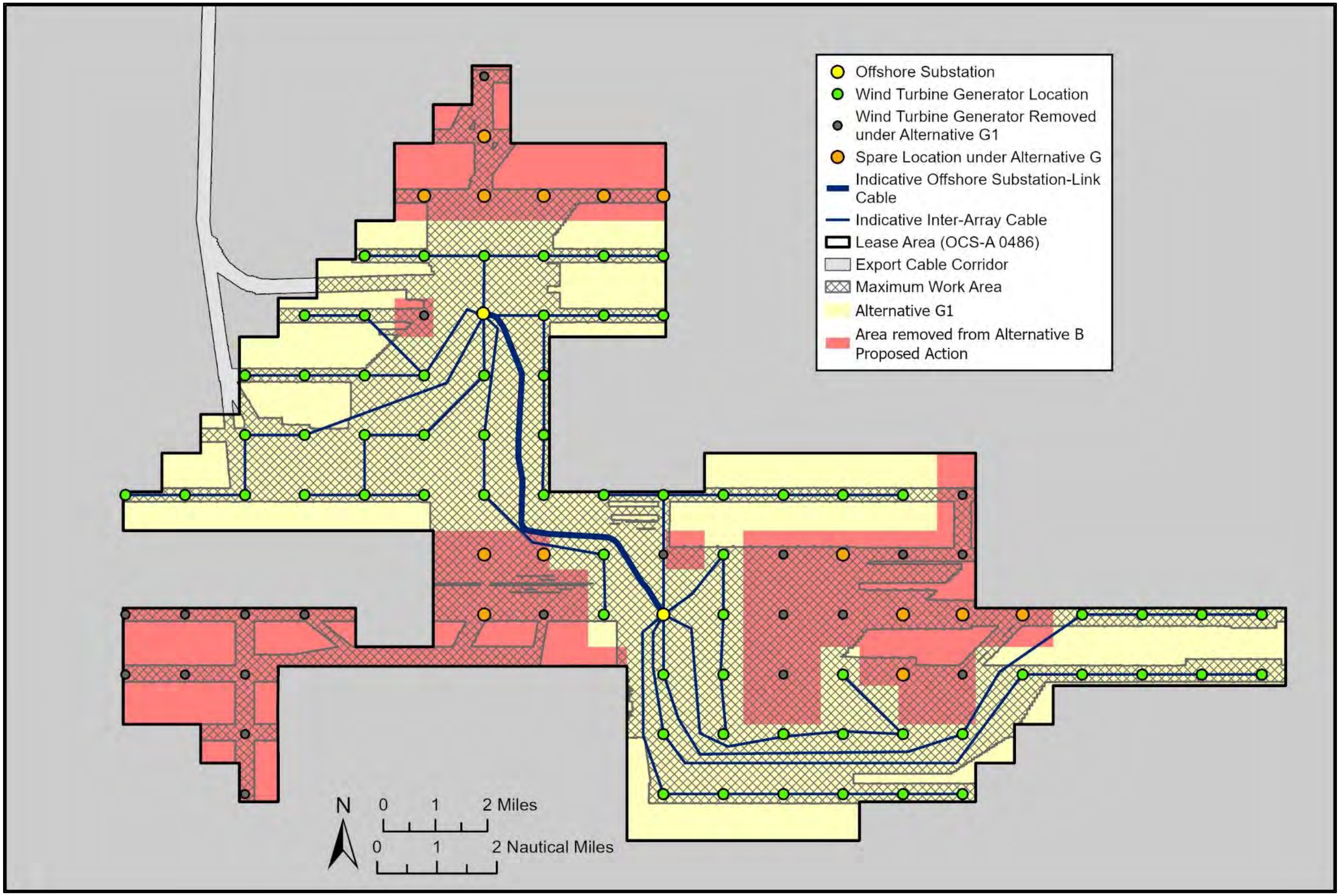


Figure 2.1-23. Project location and components under Alternative G1.

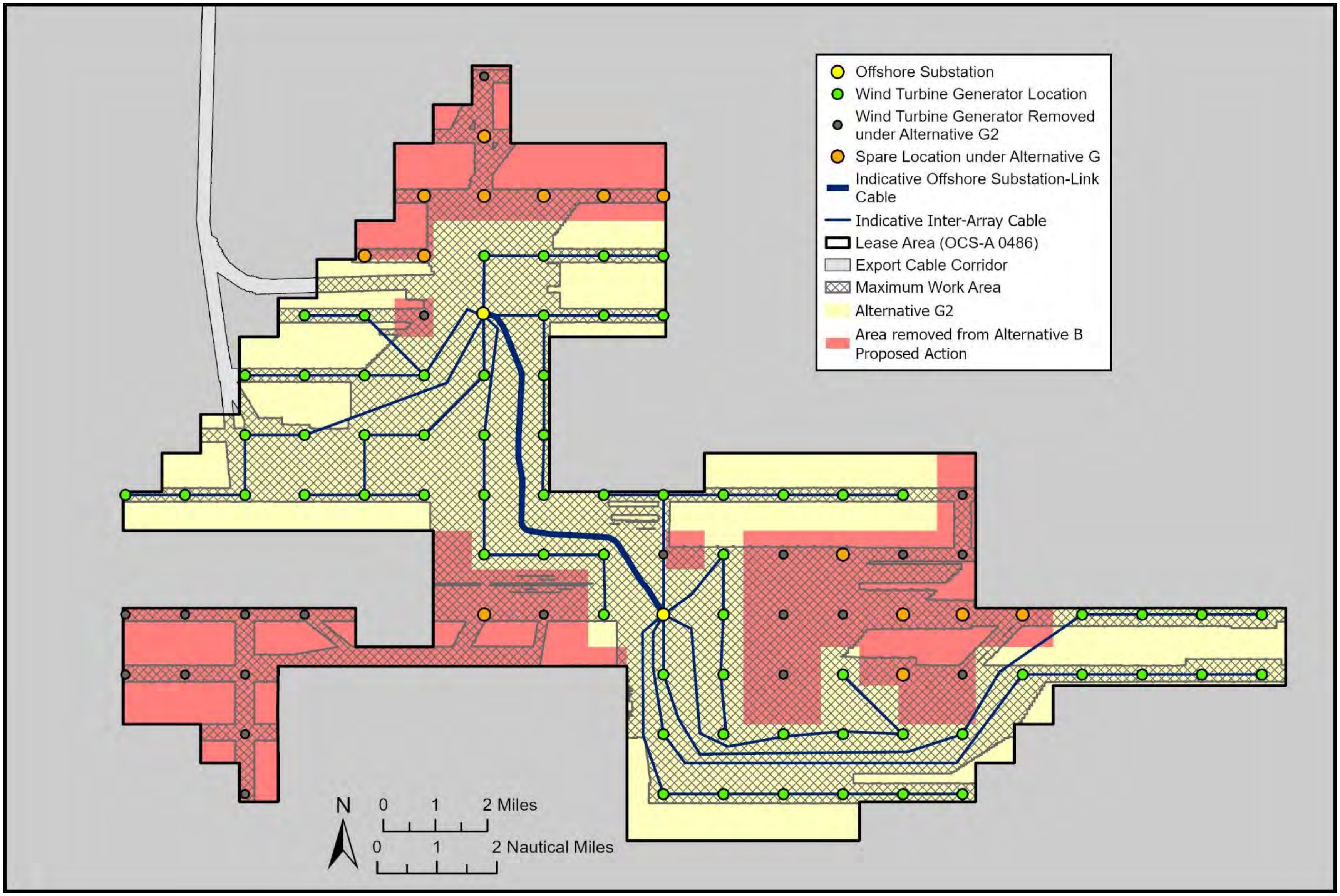


Figure 2.1-24. Project location and components under Alternative G2.

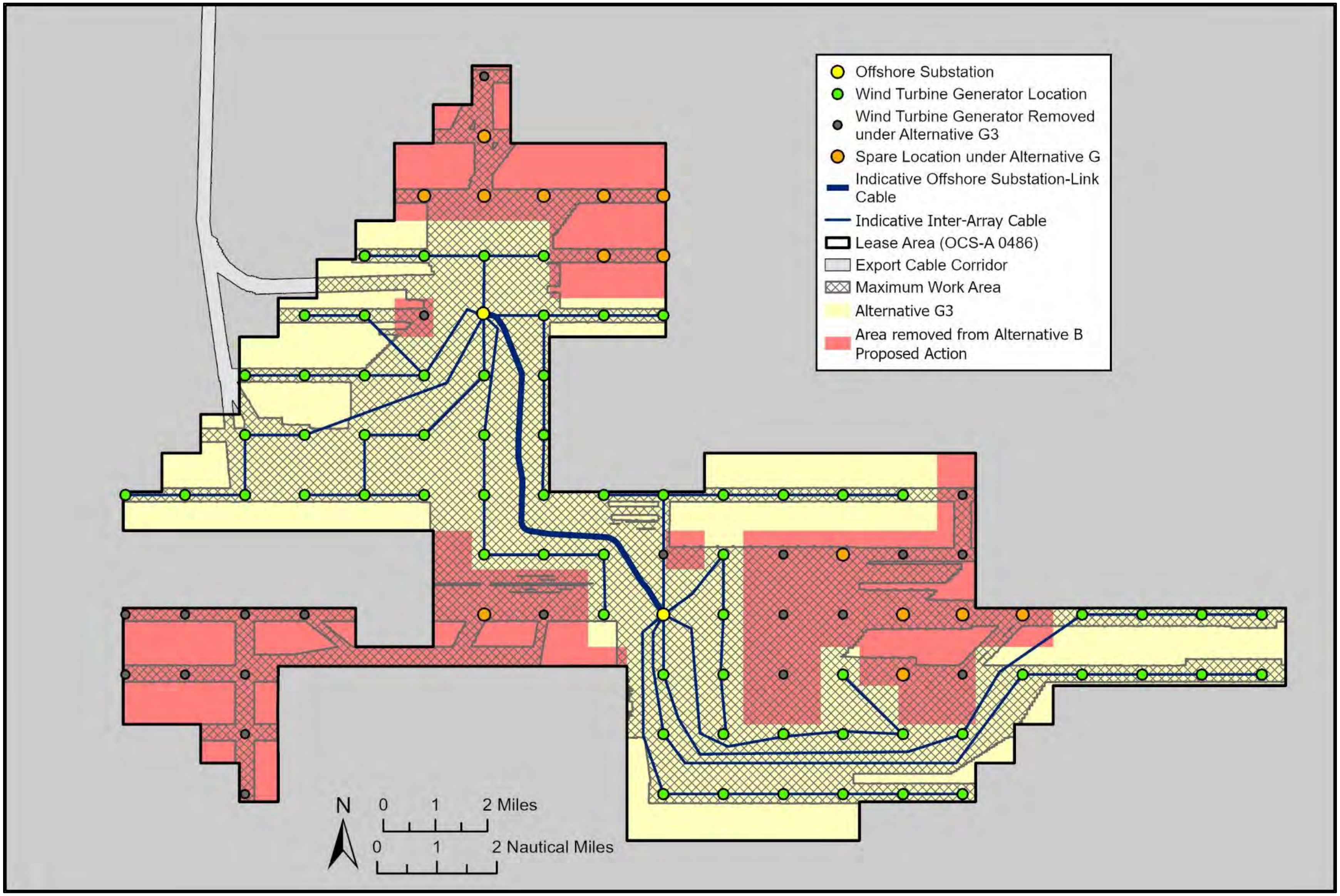


Figure 2.1-25. Project location and components under Alternative G3.

Table 2.1-20. Revolution Wind Farm Components and Footprint under the Preferred Alternative (Alternative G)

Project Component	Location	Project Envelope Characteristics	Construction and Installation Footprint	Operation Footprint
WTGs WTG monopile foundation WTG monopile scour protection	Offshore in the OCS	WTGs: Up to 65 WTGs with a nameplate capacity of 8 to 12 MW, rotor diameter of 538 to 722 feet, hub height of 377 to 512 feet above mean sea level (amsl), and upper blade tip height up to 873 feet amsl to be installed within 79 possible WTG positions WTG monopile foundation: A diameter of 20 to 39 feet and a target burial depth of 98 to 164 feet WTG monopile scour protection: Rock placement, mattress protection, sandbags, and/or stone bags placed prior to foundation installation*	WTG monopile foundation: 7.2 acres x 79 WTG = 568.8 acres disturbance Jack-up disturbance per WTG installation: 0.18 acre x 79 WTG x 1.15 = 16.4 acres¶ Total 79 WTG disturbance: 585.2 acres 7.2 acres x 65 WTG = 468-acre installation footprint Jack-up disturbance per WTG installation: 0.18 acre x 65 WTG x 1.15 = 13.5 acres¶ Total 65 WTG disturbance: 481.5 acres	WTG monopile foundation: 0.027 acre x 65 WTG = 1.8 acres WTG monopile scour protection: 0.7 acre x 65 WTG = 45.5 acres
OSS OSS monopile foundation OSS monopile scour protection	Offshore in the OCS	OSS: Up to two OSSs (OSS1 and OSS2) and up to 262 feet amsl (with lightning protection) OSS monopile foundation: A diameter of 20 to 49 feet and a maximum embedment depth of 164 feet OSS monopile scour protection: Rock placement, mattress protection, sandbags, and/or stone bags placed prior to foundation installation*	OSS monopile foundation: 7.2 acres x 2 OSS = 14.4 acres Jack-up disturbance per OSS installation: 0.18 acre x 2 OSS = 0.36 acre Total OSS disturbance: 14.8 acres	OSS monopile foundation: 0.043 acre x 2 OSS = 0.086 acres OSS monopile scour protection: 0.7 acre x 2 OSS = 1.4 acres

Project Component	**Location**	**Project Envelope Characteristics**	**Construction and Installation Footprint**	**Operation Footprint**
Alternative G (base) IAC IAC protection	Offshore in the OCS	IAC: Up to a 117-mile total length with a 72-kilovolt (kV) AC cable with a diameter of 8 inches connecting WTGs and OSSs IAC protection: Rock berms, concrete mattresses, fronded mattresses, and/or rock bags constituting up to 10% of the route for each cable	IAC: 1,862 acres	IAC protection: 55.9 acres§
Alternative G1 IAC IAC protection	Offshore in the OCS	IAC: Up to a 107-mile total length with a 72-kV AC cable with a diameter of 8 inches connecting WTGs and OSSs IAC protection: Rock berms, concrete mattresses, fronded mattresses, and/or rock bags constituting up to 10% of the route for each cable	IAC: 1,703 acres	IAC protection: 51.2 acres§
Alternative G2 IAC IAC protection	Offshore in the OCS	IAC: Up to a 105-mile total length with a 72-kV AC cable with a diameter of 8 inches connecting WTGs and OSSs IAC protection: Rock berms, concrete mattresses, fronded mattresses, and/or rock bags constituting up to 10% of the route for each cable	IAC: 1,671 acres	IAC protection: 50.2 acres§
Alternative G3 IAC IAC protection	Offshore in the OCS	IAC: Up to a 105-mile total length with a 72-kV AC cable with a diameter of 8 inches connecting WTGs and OSSs IAC protection: Rock berms, concrete mattresses, fronded mattresses, and/or rock bags constituting up to 10% of the route for each cable	IAC: 1,671 acres	IAC protection: 50.2 acres§
OSS-link cable† OSS-link cable protection	Offshore in the OCS	OSS-link cable: Up to a 9-mile-long 275-kV high-voltage AC OSS-link cable with a diameter of 11.8 inches connecting OSS1 and OSS2 OSS-link cable protection: Rock berms, concrete mattresses, fronded mattresses, and/or rock bags constituting up to 10% of route for each cable	148 acres	4.4 acres
Vessel anchoring and mooring	Offshore in the OCS, state waters, along the RWEC offshore	Vessels for cable laying may anchor within the 1,640-foot-wide Project easement.	Not provided	N/A

Project Component	Location	Project Envelope Characteristics	Construction and Installation Footprint	Operation Footprint
	route, and at the cable landfall	Anchors for cable-laying vessels have a maximum penetration depth of 15 feet. Jack-up vessels for foundation and WTG installation would include up to four spudcans with a maximum penetration depth of 52 feet and would occur within the 656-foot radius around foundation locations.	Per the COP, vessel anchoring and mooring may occur at any location in the APE.‡	

Source: VHB (2023).

Note: COP Tables 1.2-1, 3.3.4-1, 3.3.4-2, 3.3.5-1, 3.3.6-1, 3.3.6-2, 3.3.7-1, 3.3.7-2, and 4.1.1-1 provide assumptions used to develop the footprint estimates.

* As described in COP Section 3.3.4.2, scour protection would be installed around foundations. Several types of scour protection may be considered, including rock placement, mattress protection, sandbags, and stone bags. However, rock placement is the most frequently used solution. The design typically includes a sloped outer edge that meets the natural grade of the seafloor to the extent practicable. Depending on the nature of the rock used, the size would vary, but the average diameter would be approximately 8 inches (20 centimeters [cm]). Scour protection depth at monopile foundations would be approximately 2.2 to 4.6 feet above the seafloor. Additional details for the engineering specifications for the rock required for use as scour protection at the RWF are provided in the COP. Any rock used for scour protection would meet these specifications. COP Appendix H, Supplemental Project Information (BOEM 2021a), also includes a conceptual drawing for cable/scour protection at foundations. Engineering specifications for rock, a naturally occurring material, are as follows:

- Rock class: LMA5/40
- Particle density: 165 pounds per cubic foot
- Armor stone rock class
- Rock material must have been produced from blasted rock faces and may not be sourced from riverbed mining/extraction or equivalent.
- Mudstone, shale, and slate rock or similar rock likely to cleave during handling are not acceptable.
- The armor stone may not in general be flaky or elongated.

† The OSS-link cable would have similar design and construction parameters as the RWEC (see Section 2.1.2.3.1).

‡ COP Section 3.3.10.2 states that seafloor impacts from general construction vessel anchoring may occur anywhere within the identified APE centered on cable routes. The total amount of seafloor disturbance due to vessel anchorage cannot be estimated but is considered a temporary impact and not to occur outside of the surveyed area.

§ The general disturbance corridor width for the IAC is 131 feet (40 meters). IAC protection is calculated by multiplying a portion (10%) of the cable route by the disturbance corridor.

¶ Revolution Wind assumes that 15% of the WTG foundations would need an additional jack-up.

2.1.8 Alternatives Considered but Dismissed from Detailed Analysis

BOEM considered a range of alternatives during the EIS development process that emerged from scoping, interagency coordination, government-to-government consultation, and internal BOEM deliberations. To be carried forward for analysis, all considered alternatives were required to meet the following screening criteria: 1) meet the purpose of and need for the Proposed Action; 2) be operationally, technically, and economically feasible and implementable; 3) be consistent with other local, state, or federal plans, permits, and regulations; 4) further reduce or avoid impacts as compared to the Proposed Action; and 5) not be substantially the same as another alternative.

Additionally, the alternatives should be "reasonable," which the DOI has defined in 43 CFR 46.420(b) as those that are "technically and economically practical or feasible and meet the purpose and need of the proposed action."[15] There should also be evidence that each alternative would avoid or substantially lessen one or more potential, specific, and significant socioeconomic or environmental effects of the Project (43 CFR 46.415(b)). Alternatives that could not be implemented if they were chosen (for legal, economic, or technical reasons), or do not resolve the need for action and fulfill the stated purpose in taking action to a large degree, are therefore not considered reasonable. Appendix K provides additional rationale on the evolution of all alternatives.[16]

Table 2.1-21 summarizes the alternatives considered but dismissed from detailed analysis along with rationale for elimination.

[15] The terms *practical* and *feasible* are not intended to be synonymous (73 *Federal Register* 61331, October 15, 2008).

[16] BOEM received information from the Project proponent indicating that there were technical difficulties associated with installing turbines at 21 of the positions and that some of these positions would be needed to fully implement Alternatives C, D, and E. BOEM independently evaluated this information and that information was part of the basis of developing Alternative G.

Table 2.1-21. Alternatives Considered but Dismissed from Detailed Analysis

Alternative	Rationale for Dismissal
Alternative location closer to shore to minimize transmission losses.	Functionally equivalent to selecting the No Action Alternative because it is not a viable alternative that can be implemented by Revolution Wind if outside the Lease Area. Locating the proposed wind energy facility outside the Lease Area is not allowed under the terms of the lease; would not be responsive to Revolution Wind's goals to construct and operate a commercial-scale offshore wind energy facility in the Lease Area; and would not meet BOEM's purpose and need to respond to Revolution Wind's proposal and determine whether to approve, approve with modifications, or disapprove the COP to construct, operate and maintain, and decommission a commercial-scale offshore wind energy facility within the Lease Area. Consistent with BOEM's screening criteria, this alternative is dismissed from detailed consideration because it is not consistent with BOEM's purpose and need and would result in activities that are not allowed under the lease.
Alternative using the largest available WTGs to minimize the number of foundations constructed to meet the Project capacity and thereby minimize impacts to marine habitats and resources and reduce navigation and other space-use concerns.	Alternatives C through F (Habitat, Transit, Viewshed, and Higher Capacity Turbine Alternatives) already contemplate a reduction in the number of turbines to reduce impacts to habitat and navigation, viewsheds, and other sensitive resources. Alternative F analyzes the use of a higher capacity turbine provided it falls within the physical parameters of the PDE and is commercially available to the Project proponent within a reasonable time frame of the construction and installation schedule proposed in the COP. Hence the objective of this proposed alternative can be effectuated through those alternatives, or a combination thereof, if chosen. Updating the COP to include the "largest" capacity turbines has the potential to cause delays that would make the Project infeasible given that the largest-capacity turbines currently commercially available are not available within the proposed construction time frame for the Proposed Action, nor are they within the physical design parameters proposed in the COP and evaluated in this EIS. A larger WTG than what is contemplated under Alternative F would require an update to the COP, additional NEPA review, and reinitiation of the NEPA process. Thus, the impact of such an alternative would effectively equate to selection of the No Action Alternative.
Fisheries Habitat Impact Minimization Alternative (Habitat Alternative), including micrositing and reduction of the total number of foundations installed in the Lease Area as well as micrositing and reduction of the linear feet of cabling in the Lease Area. This alternative would be supported by location-specific benthic and habitat characterizations, with discussion of the most	Functionally equivalent to Alternative C (Habitat Alternative); proposed for detailed analysis.

Alternative	Rationale for Dismissal
and least impacted areas within the Lease Area for placement of Project components, and would require preconstruction survey work.	
Fisheries Habitat Impact Minimization Alternative for the export cable route. This alternative would be the construction, O&M, and eventual decommissioning of a wind energy facility within the PDE and implementation of applicable EPMs described in the COP, as referenced in Alternative B (the Proposed Action). However, to reduce impacts to complex fisheries habitats as compared to the Proposed Action, BOEM would require Orsted to consider routing the export cable to avoid complex habitats and maximize cable burial along the cable route.	As summarized in Section 2.1.2 of the COP, beginning in 2017, Revolution Wind conducted comprehensive desktop studies of oceanographic, geologic, shallow hazards, archaeological, and environmental resources such as tidal waters and wetlands in the Lease Area and the cable route (VHB 2023). These desktop studies informed the preliminary siting of the Project and supported the development of COP survey plans, which were conducted in 2017, 2018, and 2019. The purpose of the COP surveys was to conduct site characterization, marine archeological, and benthic studies necessary to further evaluate the seafloor in the Lease Area and along potential RWEC routes. The COP survey plans were submitted in accordance with the stipulations of the Lease as well as the following BOEM regulations and BOEM's guidelines: Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR 585, dated May 27, 2020 (BOEM 2020a) Guidelines for Submission of Spatial Data for Atlantic Offshore Renewable Energy Development Site Characterization Surveys, dated February 1, 2013 (BOEM 2013) Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR 585, dated May 27, 2020 (BOEM 2020b) Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585, dated June 2019 (BOEM 2019) Guidelines for Information Requirements for a Renewable Energy Construction and Operations Plan (COP), dated May 27, 2020 (Version 4.0) (BOEM 2020c) Between the Lease Area and shore, Revolution Wind reviewed available data potentially affecting route suitability, such as seafloor slope, geological hazards, tidal currents and waters, wetlands, submarine utilities, dumping grounds, shipwrecks and other seafloor obstructions, unexploded ordnances, munitions and explosives of concern, existing cable crossings, anchorage/mooring areas, pilot boarding zones, navigational safety zones, and U.S. Department of Defense military practice areas. Through the extensive survey work conducted as part of the site assessment phase, BOEM and the operator did not identify cable route alternatives during Project development that would further reduce or avoid benthic impacts (see Section 2.2.1 of the COP). Significant changes to the proposed export corridor would likely result in substantial cost for the applicant, could be counter to BOEM policy objectives of responsible and orderly development of the OCS under the OCSLA, and have not been determined as necessary based on stakeholder feedback provided to date. In addition, a site-specific cable burial risk assessment would be

Alternative	Rationale for Dismissal
	completed with additional approvals conducted at the facility design report/facility installation report stage prior to installation of any cables. No alternative cable route(s) have been proposed that are meaningfully different from those already evaluated, which also include supporting evidence of significantly reducing impacts when compared to the Proposed Action or that address impacts that could not be addressed in the site-specific cable burial risk assessment.
Alternative that uses common cable routing corridors with adjacent projects to facilitate avoidance and minimization of impacts to resources by reducing the number of corridors and allowing for programmatic-level review and comment.	The cable route for a project is primarily governed by where the energy needs to be delivered. For a corridor to be even possible, different projects would need to deliver the energy to areas that, at a minimum, are located in the general direction of where all the projects in the corridor need to deliver the power. The Project intends to deliver power to the existing Davisville Substation in North Kingstown, Rhode Island, and none of the projects for which COPs are under consideration intend to deliver power to areas that will have cables located in that general location. Therefore, it is impossible to analyze any reasonable cable routing corridor for the Project. Further, cable route planning for the Project is complex, and there is limited flexibility to accommodate major changes. In general, granting overlapping easements could unreasonably interfere with the rights of the lessee with the existing project easement or be inconsistent with the purpose for granting that existing easement. The Bureau of Safety and Environmental Enforcement (BSEE) TAP-722 *Offshore Wind Submarine Cable Spacing Guidance* (BSEE 2014) notes that circumstances vary considerably locally and that spacing between cables should be considered on a case-by-case basis and incorporate all relevant information (e.g., shipping and fishing data, ground conditions, installation and repair techniques) and taking into account site- and route-specific risk assessment. Establishing shared export cable routes does not fully allow the incorporation of local, specific, and nuanced information for individual projects, and making this type of programmatic decision is outside the scope of this EIS. This alternative could limit the flexibility of both the developer and regulatory authorities for this and adjacent projects. For example: There are significant safety and technological concerns around cable maintenance and repair. Developers generally require a corridor whose width is two to four times the depth of the water column to allow sufficient space for repairs. Developers strive for the least amount of cable to minimize installation cost and time, seafloor disturbance, and transmission loss; therefore, a shift in plans could not be cost effective for the applicant and could be counter to BOEM policy objectives of responsible and orderly development of the OCS under OCSLA. Increased Project cost and technical difficulties. Cable spacing needs to consider ongoing access to structures for O&M. Installation, repair, and maintenance are expected to occur at different times for adjacent projects, requiring infrastructure already in place to be disturbed when it otherwise would not be, which adds an additional element of risk.

Alternative	Rationale for Dismissal
	As explained above, the export corridors for currently proposed Rhode Island and Massachusetts wind facilities offer little to no opportunity for alignment, and implementation would be impossible.
Alternative to require developers to be responsible for removing offshore wind equipment if and when their project ends and further require offshore wind developers and operators to place adequate resources in trust to ensure that decommissioning would occur regardless of bankruptcy, change of ownership, or lack of profitability.	BOEM regulations (30 CFR 285, Subpart I) currently require the removal of the cables by lessees. BOEM also has policies in place to ensure that the government will not incur decommissioning expenses due to company bankruptcy (30 CFR 585.515–585.537).
Alternate turbine foundation technologies.	The use of alternative foundation types, including suction-bucket foundations and floating wind turbine foundations, to reduce impacts on marine mammals, sea turtles, and fish from pile driving associated with monopile and jacket foundation is not feasible within the Lease Area because of the following: 1. The dense soils beneath an upper loose surficial layer of sand may prevent the full penetration required for stability of suction-bucket foundations. 2. The loose upper layer of sandy sediment also presents a settlement risk for gravity-based foundations. 3. The water depths are too shallow in portions of the Lease Area for floating foundations. Although these foundation types would not require pile driving, the larger footprint of suction-bucket foundations would increase seafloor disturbance; additionally, all alternate foundation types would create less room for fishing activities between turbines when compared to monopile foundations. The cables associated with floating wind turbines would also increase the risk of entanglement for marine mammals. Overall, these alternative foundation types are not feasible in the Lease Area and may increase long-term environmental impacts to some resources over those from monopile foundations within the Lease Area.
Transit Lane Alternative with lanes at least 4 nm wide, where no surface occupancy would occur.	Aspects of this proposed alternative were incorporated into Alternative D (Transit Alternative), which analyzes setbacks from the Buzzard's Bay Traffic Separation Scheme Inbound Lane and removes overlap with the proposed RODA lanes in which no surface occupancy would be allowed. The WTGs removed under Alternative C (Habitat Alternative) could also contribute to enhanced navigation in the Lease Area equivalent to a 4-nm-wide buffer lane with no surface occupancy. Furthermore, no additional setbacks regarding navigation concerns were identified beyond those under consideration in Alternative D (Transit Alternative).

Alternative	Rationale for Dismissal
	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. In fact, RODA's February 22, 2019, comment letter on the Vineyard Wind 1 Draft EIS 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. In November 2019, the Northeast leaseholders' agreement was reached to align project layouts and avoid irregular transit corridors (Geijerstam et al. 2019). Adding transit corridors could erode project economics and logistics and potentially lead the lessee to retract from the agreement, which it committed to assuming that no additional transit lanes would be required. The 1 × 1–nm standard and uniform grid pattern with at least three lines of orientation and standard spacing to accommodate vessel transits, traditional fishing operations, and SAR operations, throughout the MA/RI WEA was informed by the Massachusetts and Rhode Island Port Access Route Study.
Alternative related to location, burial depth, and spacing of export cables and IACs to minimize environmental or fishing operations and transit impacts, with the depth of burial deeper than 4 to 6 feet.	Substantially similar in design and encompassed within Alternative C (Habitat Alternative). The target burial depth in specific areas along the cable routes will be determined based on an assessment of seafloor conditions, seafloor mobility, the risk of interaction with external hazards such as fishing gear and vessel anchors, and a required Cable Burial Risk Assessment (CBRA). The burial depth requirement would be evaluated and applied to any action alternative, and BOEM can develop and apply any appropriate mitigation measures as a result. If adequate avoidance could not be achieved through mitigation, then BOEM could require an update to the COP that could require additional NEPA review and, if warranted, could lead to selection of the No Action Alternative. The rationale for dismissal of the Fisheries Habitat Impact Minimization Alternative for the export cable route listed above in this table is also incorporated by reference here.
Alternative related to location and spacing of WTGs within the Lease Area to minimize environmental or fishing operations and transit impacts, with spacing farther apart than 1 × 1 nm.	Substantially similar in design and encompassed within Alternative C (Habitat Alternative) and Alternative D (Transit Alternative). Furthermore, no additional lanes were identified beyond those under consideration in the Alternative D (Transit Alternative) that would constitute wider spacing nor did any feedback from the USCG indicate a need for additional lanes based on the volume and types of vessels anticipated to be transiting within the wind farm area. The 1 × 1–nm grid is supported by the MARIPAS and maximizes safety and navigation consistency. The USCG also asserted that 1 × 1–nm grid spacing provides ample maneuvering space for typical fishing vessels expected in the project area. The final Massachusetts and Rhode Island Port Access Route Study did not recommend implementation of a wider transit lane. Also, analysis of AIS data indicates that 1 × 1–nm grid spacing between WTGs is sufficient for fishing vessels to turn and navigate within the proposed WEA, and

Alternative	Rationale for Dismissal
	no other available information indicates that increased spacing between WTGs would enhance maneuverability of vessels fishing within the WEA. All Rhode Island and Massachusetts offshore wind leaseholders have committed to implementing a 1 × 1–nm WTG grid layout in east-west orientation in response to stakeholder feedback. The Rhode Island and Massachusetts Lease Area developers' agreement was reached in order to avoid irregular transit corridors. Deviation from the 1 × 1–nm grid agreed to by developers would need to be considered for the entire WEA and not one to two projects. The adjoining lease areas must have the same grid throughout or at least a buffer area across borders to allow for safe navigation. Wider spacing (unless it was on axis 2 × 2 nm, which would not meet the purpose and need) would mean mismatched layouts between RWF and leases farther south and east. Increasing spacing would directly affect the size of generators needed. The Navigation Safety Risk Assessment (DNV GL Energy USA, Inc. 2020) modeled 144 structures at a minimum of 0.6 nm apart and each 10 meters in diameter (i.e., very conservative). The modeling found very minimal risks from the Project as proposed. Additional buffers or corridors beyond what was analyzed in the Navigation Safety Risk Assessment was not deemed warranted.
Alternative that combines the most disruptive components for each option included in the PDE.	This proposed alternative is considered under the Proposed Action as BOEM's analysis focuses on the most impactful parameters or combination of parameters by resource area.
Alternative that includes infrastructure design technologies that differ from those proposed in the COP that may pose lesser impacts on sensitive environmental resources.	The COP (Section 2.2) thoroughly analyzes different design parameters and technologies and includes rationale for what is proposed in the PDE and why parameters outside the PDE were eliminated. This submitted alternative lacks specificity for BOEM to meaningfully analyze it in detail. The EIS will consider various methods as part of the PDE for all alternatives, and hence this separate proposed alternative is unnecessary for ensuring their consideration.
Alternatives to avoid development of offshore wind in 1) seasonal management areas and 2) areas where persistent or long-duration dynamic management areas are established and extended for more than 3 months in any 1 year of the most recent 5 years.	To be considered as proposed mitigation.
Alternative Davisville POI overland onshore cable route to lessen potential adverse impacts on the aquatic ecosystem.	Based on post–Draft EIS comments from the EPA, NOAA and USACE, two alternative onshore cable routes to the Davisville point of interconnect were identified and analyzed through a desktop analysis, known as Davisville Alternate 1 (A1) and Davisville Alternate 2 (A2). Davisville A1 and A2 were not carried forward due

<table>
<tr><th>Alternative</th><th>Rationale for Dismissal</th></tr>
<tr><td></td><td>to several reasons relating to their 1) substantial increase in impacts to the human environment that outweigh potential benefits and 2) their technical and economic impracticality and infeasibility as described below:
The Davisville selected route (the onshore route used in all action alternatives analyzed in the EIS) would impact substantially less area of Special Aquatic Sites (including wetlands) than Davisville A1 and A2. The Davisville selected route would impact approximately 4,300 square feet of wetlands through tree cutting only. In contrast, Davisville A1 would impact approximately 13,500 square feet of wetlands, and Davisville A2 would impact approximately 144, 000 square feet of wetlands. In contrast, the amount of dredge material would be the same across all three alternatives. The amount of fill material would be 5.4 acres for Davisville A1 and A2 assuming a best case that there are no submarine utility cables, which is currently unknown. The amount of fill for the Davisville selected route would be 11 acres, which does not account for the presence of seven submarine utility cables. The substantially larger impacts to wetlands (triple for A1 and over 33 times more for A2) outweigh the reduction in fill material, especially in light of the potential for additional fill to be needed for Davisville A1 or A2 if submarine utility cables were identified.
Conflict with Department of Defense uses due to the need to cross a torpedo testing range.
Conflict with USCG Traffic Separation Scheme due to the need to cross the scheme.
Economic and technical impracticality and infeasibility due to a combination of the 1) lack of site-specific geophysical survey data for offshore portions; 2) lack of state and municipal permits; 3) lack of private real estate rights; 4) and increased costs of approximately $60 million, without accounting for project delays. Moreover, together, the time it would take to obtain the data, permits, and site control, if obtainable at all, would significantly delay onshore construction a minimum of 6 months, if not much more.
Please see Appendix K for additional specifics for Davisville A1 and Davisville A2.</td></tr>
</table>

2.2 Non-Routine Activities and Low-Probability Events

Non-routine activities and low-probability events associated with the Project could occur during construction and installation, O&M, or decommissioning. Although these activities or events are impossible to predict with certainty, examples of such activities and events and potential for Project impacts are briefly summarized in Table 2.2-1.

Table 2.2-1. Non-Routine Activities and Low-Probability Events Associated with the Project

Activity or Event	Potential for Project Impacts
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. Revolution Wind would stock spare parts and have sufficient workforce available to conduct corrective maintenance activities, if required. Non-routine WTG, OSS, and cable maintenance are discussed in detail in COP Section 3.5.2, 3.5.3, and 3.5.4.
Collisions and allisions	These activities could result in spills (described below) or injuries or fatalities to humans and/or wildlife (addressed in Chapter 3). Collisions and allisions would likely be minimized through the USCG's requirement for lighting on vessels, temporary safety zones anticipated to be implemented by Revolution Wind during construction, implementation of NOAA vessel-strike guidance, proposed spacing between WTGs and other facility components, and inclusion of Project components on nautical charts. See COP Appendix R for additional information (DNV GL Energy USA, Inc. 2020).
Cable displacement or damage by vessel anchors or fishing gear	This could result in safety concerns and economic damages to vessel operators. However, such incidents would be minimized by the inclusion of Project components on nautical charts and the cable burial or other protection measures.
Chemical spills or releases	For offshore activities, these would include inadvertent releases from refueling vessels, spills from routine maintenance activities, and any significant spills as a result of other accidental events. Revolution Wind would comply with USCG and BSEE regulations relating to prevention and control of oil spills. Onshore, releases could occur from construction equipment and/or HDD activities. Revolution Wind would prepare a construction spill prevention, control, and countermeasures (SPCC) plan in accordance with applicable requirements and would outline spill prevention plans and measures to take to contain and clean up spills that could occur. See COP Appendix D for additional information.
Severe weather (e.g., hurricanes) and natural events	Revolution Wind designed the Project components to withstand severe weather events. However, severe flooding or coastal erosion could require repairs during construction and installation activities. Although highly unlikely, structural failure of a WTG (i.e., loss of a blade or tower collapse) would result in temporary hazards to navigation for all vessels. Information related to WTG and OSS design is found in COP Section 3.3.8.1. In the event of significant facility damage, Revolution Wind would follow requirements for submitting notifications to BSEE, as described in 30 CFR 285.831. 30 CFR 285.703 defines the obligation to submit a report on repairs. Surveys, such as those to be performed after a major storm event, would be conducted to evaluate seafloor conditions. Results of surveys would be shared with relevant regulatory authorities, and remedial plans would be agreed to and implemented subject to applicable regulations.

Activity or Event	Potential for Project Impacts
Medical events	Illness or injury of construction or operation crew could result in emergency medical services requiring vessel or aircraft/helicopter trips. However, Revolution Wind would comply with all local emergency management plans and coordinate with local emergency officials to minimize risks associated with medical events.
Terrorist attacks	Impacts from terrorist attacks (including cyber-attacks) could vary greatly in magnitude and extent and therefore their analysis would be highly speculative. BOEM also considers terrorist attacks unlikely, and therefore, does not analyze them further in the EIS.

2.3 Summary and Comparison of Impacts Among Alternatives without Mitigation Measures

2.3.1 Comparison of Impacts by Alternative

Table 2.3-1 provides a summary and comparison of the impacts under the No Action Alternative and each action alternative assessed in Chapter 3. Under the No Action Alternative, any potential environmental and socioeconomic impacts, including benefits, associated with the Proposed Action or Preferred Alternative would not occur; however, impacts could occur from other ongoing and planned activities. This table also provides a summary of the overall cumulative impacts by environmental resource and alternative. Each resource has two rows; one for the comparison of impacts and one for the overall cumulative impacts. The overall cumulative impacts for each resource include the alternative impacts combined with all planned activities (including other offshore wind activities). Chapter 3 resources include IPF-specific impact determinations that do differ from the overall impact determination and could be less than what is indicated in Table 2.3-1.

Green cell color represents negligible to minor adverse overall impact. Yellow cell color represents moderate adverse overall impact. Orange cell color represents major adverse overall impact. Resources with beneficial impacts are denoted by an asterisk, and alternatives within those resource rows with beneficial impacts are denoted by a bolded blue outline and an asterisk. Detailed comparisons of both adverse and beneficial impacts by environmental resource and alternative, as well as evaluation of impacts across alternatives by impact producing factor, are provided in each resource area within Chapter 3.

Table 2.3-1. Comparison of Alternatives and Overall Cumulative Impacts by Alternative

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Air quality – Alternative impacts*	Continuation of current air quality trends and sources of air pollution would be **moderate** adverse.	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*
Air quality: – Cumulative impacts*	**Minor** to **moderate** adverse; **minor** to **moderate** beneficial*	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse
Bats: Alternative impacts	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **negligible** adverse.	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse
Bats: Cumulative impacts	**Negligible** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Benthic habitat and invertebrates: Alternative impacts*	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **minor** to **moderate** adverse.	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*
Benthic habitat and invertebrates: Cumulative impacts*	**Minor** to **moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*
Birds: Alternative impacts	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **minor** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Birds: Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Coastal habitats and fauna: Alternative impacts	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **negligible** adverse.	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse
Coastal habitats and fauna: Cumulative impacts	**Negligible** to **minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Commercial fisheries and for-hire recreational fishing: Alternative impacts*	Continuation of current trends would be **moderate** to **major** adverse for commercial fisheries and **minor** to **moderate** adverse and **minor** beneficial for for-hire recreational fishing.*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*	**Negligible** to **major** adverse; **minor** beneficial*
Commercial fisheries and for-hire recreational fishing: Cumulative impacts*	**Moderate** to **major** adverse for commercial fisheries; **minor** to **moderate** adverse and **minor** beneficial for for-hire recreational fishing*	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse
Cultural resources: Alternative impacts	Continuation of individual IPF impacts to cultural resources from past and current activities would be **negligible** to **major** negative.†	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†
Cultural resources: Cumulative impacts	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†	**Negligible** to **major** negative†
Demographics, employment, and economics: Alternative impacts*	Continuation of current trends would be **moderate** to **major** adverse and **minor** to **moderate** beneficial.*	**Negligible** to **moderate** adverse; **minor** beneficial*	**Minor** beneficial*	**Minor** beneficial*	**Minor** beneficial*	**Minor** beneficial*	**Minor** beneficial*
Demographics, employment, and economics: Cumulative impacts*	**Major** adverse; **minor** to **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*	**Major** adverse; **moderate** beneficial*
Environmental justice: Alternative impacts*	Continuation of current trends would be **negligible** to **major** adverse and **negligible** to **moderate** beneficial.*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*	**Minor** to **moderate** adverse; **negligible** to **moderate** beneficial*
Environmental justice: Cumulative impacts	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse
Finfish and essential fish habitat: Alternative impacts*	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **moderate** adverse.	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*
Finfish and essential fish habitat: Cumulative impacts*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*	**Moderate** adverse; **moderate** beneficial*

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Land use and coastal infrastructure: Alternative impacts*	Continuation of current trends would be **minor** adverse.	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*
Land use and coastal infrastructure: Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Marine mammals: Alternative impacts*	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **moderate** adverse for all marine mammals except for the North Atlantic right whale (NARW). Continuation of population trends and human-caused stressors would be **major** for NARW.	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*	**Moderate** adverse; **minor** beneficial*
Marine mammals: Cumulative impacts*	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)	**Moderate** adverse; **minor** beneficial* (**Major** adverse for NARW)
Navigation and vessel traffic: Alternative impacts	Continuation of current trends would be **minor** to **moderate** adverse.	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Minor** to **moderate** adverse	**Moderate** adverse	**Minor** to **moderate** adverse
Navigation and vessel traffic: Cumulative impacts	**Minor** to **moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse
Other marine uses: aviation and air traffic: Alternative impacts	Continuation of current trends would be **negligible** adverse.	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse
Other marine uses: aviation and air traffic: Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Other marine uses: land-based radar: Alternative impacts	Continuation of current trends would be **negligible** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Other marine uses: land-based radar: Cumulative impacts	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse
Other marine uses: military and national security: Alternative impacts	Continuation of current trends would be **negligible** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Other marine uses: military and national security: Cumulative impacts	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse	**Moderate** adverse
Other marine uses: scientific research and surveys: Alternative impacts	Continuation of current trends would be **moderate** adverse.	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse
Other marine uses: scientific research and surveys: Cumulative impacts	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse	**Major** adverse
Other marine uses: undersea cables: Alternative impacts	Continuation of current trends would be **negligible** adverse.	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse
Other marine uses: undersea cables: Cumulative impacts	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse	**Negligible** adverse
Recreation and tourism: Alternative impacts	Continuation of current trends would be **minor** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Recreation and tourism – Cumulative impacts*	**Minor** adverse	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*
Sea turtles: Alternative impacts*	Continuation of population trends and continuation of effects to species from natural and human-caused stressors would be **minor** adverse.	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*	**Minor** adverse; **minor** beneficial*
Sea turtles: Cumulative impacts*	**Minor** adverse; **minor** beneficial*	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Visual resources: Alternative impacts	Continuation of impacts to viewsheds from past and current activities would be **negligible** to **moderate** adverse.	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse
Visual resources: Cumulative impacts	**Moderate** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse	**Negligible** to **major** adverse
Water quality – Alternative impacts	Continuation of current water quality trends and sources of pollution would be **minor** adverse.	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse
Water quality – Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse

Resource	Alternative A (No Action Alternative)	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
Wetlands and non-tidal waters: Alternative impacts	Continuation of current wetland resources trends and sources of pollution would be **negligible** adverse.	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse	**Negligible** to **minor** adverse
Wetlands and non-tidal waters: Cumulative impacts	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse	**Minor** adverse

* Resources with beneficial impacts are denoted by an asterisk, and alternatives within those resource rows with beneficial impacts are denoted by a bolded blue outline and an asterisk.

† The term “adverse” has a specific meaning under NHPA Section 106 regulations (in 36 CFR 800.5) and, therefore, to remove confusion in the Cultural Resources section, the terms “negative” and “beneficial” are used in the identification of impacts under NEPA.

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3 Affected Environment and Environmental Consequences

This chapter analyzes the impacts of the Proposed Action and action alternatives when added to the existing conditions of the affected environment. Additionally, this chapter considers the cumulative impact on the affected environment of reasonably foreseeable future planned activities, as defined in Appendix E. Appendix E describes other ongoing and planned activities within the GAA for each resource. These activities may be occurring on the same time scale as the Project or could occur later in time but are still reasonably foreseeable. The outcome of the direct, indirect, and cumulative impacts to the affected environment is the potential environmental consequences.

In compliance with NEPA regulations (40 CFR 1501.3), the EIS evaluates the significance of Project impacts based on the potentially affected environment (context) and degree of effects (intensity). Impact levels described in BOEM's 2007 *Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf, Final Environmental Impact Statement* (MMS 2007) were used as the initial basis for establishing adverse and beneficial impacts specific to each resource. These impact levels were then further refined based on scientific literature and best professional judgment and are presented in Section 3.3.

Where adverse or beneficial is not specifically noted, the reader should assume the impact is adverse.[17] These overall determinations consider the combined effects of the individual impact level for each impact-producing factor (IPF) for each resource, as addressed in Section 3.1. Where information is incomplete or unavailable for the evaluation of reasonably foreseeable impacts analyzed in this chapter, BOEM identified and conducted its analysis in accordance with Section 1502.21 of the CEQ regulations in Appendix C (Analysis of Incomplete or Unavailable Information). The No Action Alternative is first analyzed to predict the impacts to the existing condition of the effected environment (as described in Section 1.6.1). A subsequent analysis is conducted to assess the cumulative impacts to the existing condition as future planned activities occur (as described in Section 1.6.2). Separate impact conclusions are drawn based on these separate analyses. Separate analyses are also conducted in the EIS to evaluate the impacts of the action alternatives when added to the effected environment of resources (as described in Section 1.6.1) and to evaluate cumulative impacts by analyzing the incremental impacts of the action alternatives when added to both the existing condition (as described in Section 1.6.1) and the impacts of future planned activities (as described in Section 1.6.2).

3.1 Impact-Producing Factors

BOEM's 2019 study *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Outer Continental Shelf* (BOEM 2019) developed reference tables that evaluate potential impacts associated with ongoing and future offshore wind and non–offshore wind activities. The content of these tables have been re-evaluated in Appendix E1 to determine the relevance of each IPF to each resource analyzed in this EIS.

A resource's GAA is defined by the IPF with the maximum geographic area of impact. The purpose of using these GAAs is to capture the impacts from planned activities to each of those resources potentially

[17] The term "adverse" has a specific definition under Section 106 of the National Historic Preservation Act (NHPA) and therefore to remove confusion in the Cultural Resources section, the terms "negative" and "beneficial" are used in the identification of impacts under NEPA.

impacted by the Proposed Action. The GAA for each resource area is defined in the resource area sections of the EIS. GAAs are further discussed in Appendix E and complex GAAs are defined in Appendix G.

Each resource area in this chapter (Sections 3.4 to 3.22) includes a discussion of future offshore wind projects and other reasonably foreseeable activities without the Proposed Action, otherwise known as the No Action Alternative. The impacts resulting from this scenario are presented with a discussion of the IPFs for the resource area as determined by BOEM. Appendix E1 (Description and Screening of Relevant Offshore Wind and Non–Offshore Wind Impact-Producing Factors and Negligible Impact Determinations) includes lists of potential IPFs for each resource and provides a summary of IPFs analyzed for each resource across all action alternatives. Consistent with Section 1502.15 of the CEQ regulations, IPFs that are either not applicable to the resource area or are determined by BOEM to have a negligible effect are excluded from analysis in the body of the EIS and retained in Appendix E1. IPFs that result in a minor (or less) impact are retained in Appendix E2.

3.2 Mitigation Identified for Analysis in the Environmental Impact Statement

EPMs and mitigation and monitoring measures identified for the Project are identified in Appendix F (Environmental Protection Measures and Mitigation and Monitoring). EPMs (Table F-1) are those measures Revolution Wind has committed to executing in the COP and are therefore analyzed in the EIS as components of the Project design. If BOEM decides to approve the COP, BOEM could choose to require additional mitigation and monitoring measures as part of the ROD. Mitigation measures resulting from consultations between BOEM and cooperating agencies are listed in Table F-2. Additional mitigation measures identified by BOEM or cooperating agencies are listed in Table F-3. The mitigation measures identified in Tables F-2 and F-3 are analyzed in the relevant resource sections in Chapter 3. BOEM provides a separate mitigation section for each resource that identifies and discusses how and to what degree the additional mitigation measures could reduce alternative impacts. Please note that not all of these mitigation measures are within BOEM’s statutory and regulatory authority but could be adopted and imposed by other governmental entities. If BOEM decides to approve the COP, its ROD would state which of the mitigation and monitoring measures identified by BOEM in Table F-2 and Table F-3 have been adopted, and if not, why. Table F-4 identifies measures that may be required by other authorizations and permits issued to the lessee.

3.3 Definition of Impact Levels

Based on previous environmental reviews, subject matter expert input, consultation efforts, and public involvement to date, BOEM has identified the resources in Table 3.3-1 as potentially affected by the Project. These resources fall into three categories: 1) physical resources, 2) biological resources, and 3) socioeconomic and cultural resources.

The EIS uses a four-level classification scheme (negligible, minor, moderate, and major) to characterize the potential impacts of the alternatives, including the Proposed Action. Table 3.3-2 provides negative (i.e., adverse) impact levels for each resource category, whereas Table 3.3-3 provides beneficial impact levels.

Table 3.3-1. Resources Potentially Affected by the Project

Physical Resources	Biological Resources	Socioeconomic and Cultural Resources
Air quality Water quality	Bats Benthic habitat and invertebrates Birds Coastal habitats and fauna Finfish and essential fish habitat Marine mammals Sea turtles Wetlands and non-tidal waters	Commercial fisheries and for-hire recreational fishing Cultural resources Demographics, employment, and economics Environmental justice Land use and coastal infrastructure Navigation and vessel traffic Other marine uses (marine, military use, aviation, offshore energy) Recreation and tourism Visual resources

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Table 3.3-2. Definitions of Potential Adverse Impact Levels

Impact Level	Biological and Physical Resources	Socioeconomic Resources	Cultural Resources	Visual Resources
Negligible	Either no impact or no measurable impacts.	Either no impact or no measurable impacts	Impacts would be so small as to be unmeasurable (i.e., finding of "no historic properties affected" or "no historic properties adversely affected" pursuant to 36 CFR 800).	Seascape/Landscape impact assessment: Very little or no impact on seascape/landscape unit character, features, elements, or key qualities because unit lacks distinctive character, features, elements, or key qualities; values for these are low; and/or Project visibility is minimal. Visual impact assessment: Very little or no impact on viewers' visual experience because view value is low, viewers are relatively insensitive to view changes, and/or Project visibility is minimal.
Minor	Most adverse impacts on the following affected resource(s) could occur AND the affected resource would recover completely without remedial or mitigating action, including local ecosystem health; the extent and quality of local habitat for both special-status species and species common to the proposed project area; the richness or abundance of local species common to the proposed project area; and air or water quality.	Most adverse impacts on the affected activity or community, including traditional cultural practices, could be avoided; impacts would not disrupt the normal or routine functions of the affected activity or community, including traditional cultural practices; OR the affected activity or community, including traditional cultural practices, is expected to return to a condition with no measurable impacts without remedial or mitigating action.	Cultural resources (historic properties that include archaeological sites, buildings, structures, objects, and districts that are listed in or eligible for the NRHP) would be affected; however, conditions would be imposed to ensure consistency with the Secretary's Standards for the Treatment of Historic Properties (36 CFR 68) to avoid adverse impacts. (i.e., finding of "no historic properties adversely affected" pursuant to 36 CFR 800).	Seascape/Landscape impact assessment: Small but noticeable impact on seascape/landscape unit character, features, elements, or special qualities because project is somewhat inconsistent with unit character; negatively affects unit features, elements, or key qualities; and/or project visibility is low. Visual impact assessment: Change to the view would have a small but noticeable impact on visual experience because view value is low, viewers are relatively insensitive to view changes, and/or project visibility is low.
Moderate	A notable and measurable adverse impact on the affected resource(s) could occur AND the affected resource would recover completely when remedial or mitigating action is taken, including local ecosystem health; the extent and quality of local habitat for both special-status species and species common to the proposed project area; the richness or abundance of local species common to the proposed project area; and air or water quality.	Mitigation would reduce adverse impacts substantially during the life of the proposed Project, including decommissioning; the affected activity or community, including traditional cultural practices, would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts of the Project; OR once the impacting agent is gone, the affected activity or community, including traditional cultural practices, is expected to return to a condition with no measurable impacts, when remedial or mitigating action is taken.	Characteristics of cultural resources would be altered in a way that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association (i.e., finding of "historic properties adversely affected" pursuant to 36 CFR 800). Measures to resolve adverse effects would minimize impacts, and the adversely affected property would remain NRHP eligible.	Seascape/Landscape impact assessment: Substantial impact on seascape/landscape unit character, features, elements, or special qualities because the Project is clearly inconsistent with unit character; substantially negatively affects unit features, elements, or key qualities; and/or Project visibility is moderate. Visual impact assessment: The change to the view would have a substantial impact on the viewers' visual experience because view value is moderate, the viewers are moderately sensitive to the changes in the view, and/or the visibility of the Project is moderate.
Major	A regional or population-level adverse impact on the affected resource(s), could occur AND the affected resource would not fully recover, even after the impacting agent is gone and remedial or mitigating action is taken, including ecosystem health; the extent and quality of habitat for both special-status species and species common to the proposed project area; species common to the proposed project area; and air or water quality.	Mitigation would reduce adverse impacts somewhat during the life of the Project, including decommissioning; the affected activity or community, including traditional cultural practices, would have to adjust to significant disruptions due to large local or notable regional adverse impacts of the Project; AND the affected activity or community, including traditional cultural practices, may retain measurable impacts indefinitely, even after the impacting agent is gone and remedial action is taken.	Characteristics of cultural resources would be affected in a way that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association (i.e., finding of "historic properties adversely affected" pursuant to 36 CFR 800). Measures to resolve adverse effects would mitigate impacts; however, important characteristics would be altered to the extent that the adversely affected property would no longer be listed in or eligible for the NRHP.	Seascape/Landscape impact assessment: Dominant impact on seascape/landscape unit character, features, elements, or key qualities; fundamentally changes unit character, features, elements, or key qualities, and visibility of the Project is high. Visual impact assessment: Dominate visual experience either because view value is moderate to high, viewers are moderately to highly sensitive to view changes, and the visibility of the Project is moderate to high.

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Table 3.3-3. Definitions of Potential Beneficial Impact Levels

Impact Level	Biological, Physical, and Cultural Resources	Socioeconomic Resources
Negligible	Either no impact or no measurable impacts.	Either no impact or no measurable impacts.
Minor	A small and measurable improvement in ecosystem health; increase in the extent and quality of habitat for both special-status species and species common to the proposed project area; increase in populations of species common to the proposed project area; improvement in air or water quality; or Benefits to cultural resources (historic properties that include archaeological sites, buildings, structures, objects, and districts that are listed or eligible for the NRHP) would passively preserve historic properties consistent with the Secretary's Standards for the Treatment of Historic Properties or passively create conditions to protect archaeological sites.	A small and measurable improvement in human health; benefits for employment (e.g., job creation, workforce development); improvement to infrastructure/facilities and community services; economic improvement; or benefit for tourism or traditional cultural practices.
Moderate	A notable and measurable improvement in local ecosystem health; increase in the extent and quality of local habitat for both special-status species and species common to the proposed project area; increase in individuals or populations of species common to the proposed project area; improvement in air or water quality; or Benefits to cultural resources would actively preserve historic properties (historic properties that include archaeological sites, buildings, structures, objects, and districts that are listed in or eligible for the NRHP) consistent with the Secretary's Standards for the Treatment of Historic Properties.	A notable and measurable improvement in human health; benefits for employment (e.g., job creation, workforce development); improvements to facilities/infrastructure and community services; economic improvement; or benefit for tourism or traditional cultural practices.
Major	A regional or population-level improvement in the health of ecosystems; increase in the extent and quality of habitat for both special-status and commonly occurring species; improvement in air or water quality; or Benefits to cultural resources would rehabilitate, restore, or reconstruct historic properties consistent with the Secretary's Standards for the Treatment of Historic Properties, including cultural landscapes and traditional cultural properties.	A large local or notable regional improvement in human health; benefits for employment (e.g., job creation, workforce development); improvements to facilities and community services; economic improvement; or benefit to tourism or traditional cultural practices

Note: No potential for beneficial impacts to visual resources were identified; therefore, this resource category was not included in this table.

With regard to temporal extent, construction effects generally diminish once construction ends; however, ongoing O&M activities could result in additional impacts for the potential 35-year life of the Project. Additionally, Revolution Wind would have up to an additional 2 years to complete decommissioning activities. Therefore, the EIS considers the time frame beginning with construction and ending when the Project's decommissioning is complete, unless otherwise noted. Table 3.3-4 provides the duration terms used in the EIS.[18]

Table 3.3-4. Definitions of Duration Terms

Duration Term	Definitions
Long-term effects	Effects that last for a long period of time (e.g., decades or longer, including impacts beyond the life of the Project). An example would be the loss of habitat where a foundation has been installed.
Short-term effects	Effects that extend beyond construction, potentially lasting for several months, but not for several years or longer. An example would be the clearing of onshore shrubland vegetation during construction; the area would be revegetated when construction is complete, and once revegetation is successful, this effect would end.
Temporary effects	Effects that end as soon as the activity ceases. An example would be road closures or traffic delays during onshore cable installation. Once construction is complete, the effect would end.

Within the cumulative analysis, Table 3.3-5 provides the terms used in the EIS to describe the incremental impact of the action alternative in relation to the combined impacts from all ongoing and planned activities, including both non–offshore wind and offshore wind activities.

Table 3.3-5. Definitions of Incremental Impact Terms

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

[18] NMFS (2021) recommends the following temporal definitions, which have been applied to benthic and EFH resource areas in this EIS: short term (less than 2 years); long term (2 years to < life of the Project); permanent (life of the Project or longer).

3.4 Air Quality

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to air quality from implementation of the Proposed Action and other considered alternatives.

3.5 Bats

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to bats from implementation of the Proposed Action and other considered alternatives.

3.6 Benthic Habitat and Invertebrates

3.6.1 Description of the Affected Environment for Benthic Habitat and Invertebrates

This section evaluates effects to benthic habitat and invertebrate resources within their respective GAAs under the No Action Alternative, which considers the current environmental baseline and probable future conditions regarding the development of planned and probable future offshore wind energy projects on the Mid-Atlantic OCS. These ongoing activities are expected to contribute to the potential cumulative effects of the Proposed Action and other action alternatives. The characterization of existing and likely future conditions presented herein is consistent with BOEM's guidance for evaluating cumulative effects analyses for offshore wind activities on the North Atlantic OCS (BOEM 2019).

While these two resources are described separately for the purpose of this EIS, it is important to recognize that invertebrates are an important component of benthic habitat. The factors that contribute to benthic habitat function comprise the physical mixture, or composition, of substrate types (e.g., bedrock, boulders, gravel, sand, and silt) and benthic habitat structure, which comprises both the three-dimensional structure of sediments (e.g., bedrock towers and boulder piles, ripples, and megaripples in fine sediment) and the structural complexity created by habitat-forming invertebrates and other organisms. For example, certain amphipods and worms live in dense colonies of individuals enclosed in tubes buried in sand and mud. The ends of these tubes are routinely exposed by mobile sediments, providing complex structure used as cover by juveniles of several fish species. Encrusting organisms like sponges and mussel colonies that form on cobbles and boulders similarly provide complex structure, cover, spawning habitat, and foraging opportunities for fish and other invertebrates. The duration of impacts to benthic habitat from different construction activities is best understood as the time required for habitat-forming invertebrates to recover from the associated disturbance.

3.6.1.1 Benthic Habitat

<u>Geographic analysis area:</u> The GAA for benthic habitat has been defined to reflect the limited extent of impacts from Project activities on the structure and composition of the seafloor. This definition was selected because the GAA captures the extent of benthic habitat occurring within the footprint of Project activities because the seafloor sediments that comprise benthic habitats do not move or migrate at regional scales like other biological resources. This area also accounts for some transport of water masses, sediment transport, and benthic invertebrate larval transport due to ocean currents. The GAA is defined for the purpose of describing the composition of benthic habitat relevant to the effects analysis presented herein and is used primarily for analysis of cumulative impacts on this resource. Impacts to benthic habitat structure, which includes the contribution of habitat-forming organisms to benthic habitat function and impacts to finfish and EFH species that rely on these habitats, are addressed in the Environmental Consequences sections for those resources, respectively.

The GAA for benthic habitat comprises the maximum work area; selected control and reference areas for monitoring activities under the Project fisheries research and monitoring plan (FRMP) (Revolution Wind and Inspire Environmental 2023); 5,650-foot and 6,550-foot buffers on either side of the RWEC in federal and state waters, respectively; and a 1,500-foot buffer on either side of the IAC corridor over the entirety of its length, including the foundation and scour protection footprints; and a 1,500-foot buffer around the OSS-link cables over the entirety of their lengths. These areas are shown in Figure 3.6-1. FRMP survey activities will be randomly distributed within their associated control and reference areas.

As such, those areas do not represent an anticipated impact footprint; rather, they represent the broader area in which limited effects will occur. The RWEC, IAC, and OSS-link impact buffers represent the maximum extent of measurable impacts on benthic habitat composition resulting from Project construction and operations. The associated IPFs include bottom-disturbing activities such as anchoring, seafloor preparation, cable and foundation installation, and placement of cable and scour protection that would lead to localized changes in the composition and three-dimensional structure of seafloor sediments. This includes areas affected by the deposition of suspended sediments from construction-related seafloor disturbance resulting from deposition of suspended sediments disturbed during construction exceeding 0.003 inch (0.1 millimeter [mm]) in depth. They also include operational effects from the presence of structures that would lead over time to changes in seafloor composition, specifically the composition and three-dimensional structure of sediment types around WTG and OSS foundations resulting from reef effects. The encompassed area shown on Figure 3.6-1 that lies between the FRMP monitoring sites and the impact buffers within the RWF and RWEC are outside the likely extent of impacts to benthic habitat composition and are not included in the GAA.

It is important to recognize that certain habitat-forming invertebrates and other organisms that live in and on seafloor sediments are an important part of benthic habitat structure. Impacts to these organisms are influenced by and extend beyond impacts to benthic habitat composition. Because the geographic range and population structure of these organisms are influenced by oceanic currents and stratification patterns, the geographic extent of potential cumulative impacts on invertebrates that contribute to benthic habitat structure is necessarily broader than that for substrate composition and are analyzed separately. The GAA for invertebrates, including habitat-forming invertebrates, is described in Section 3.6.1.2.

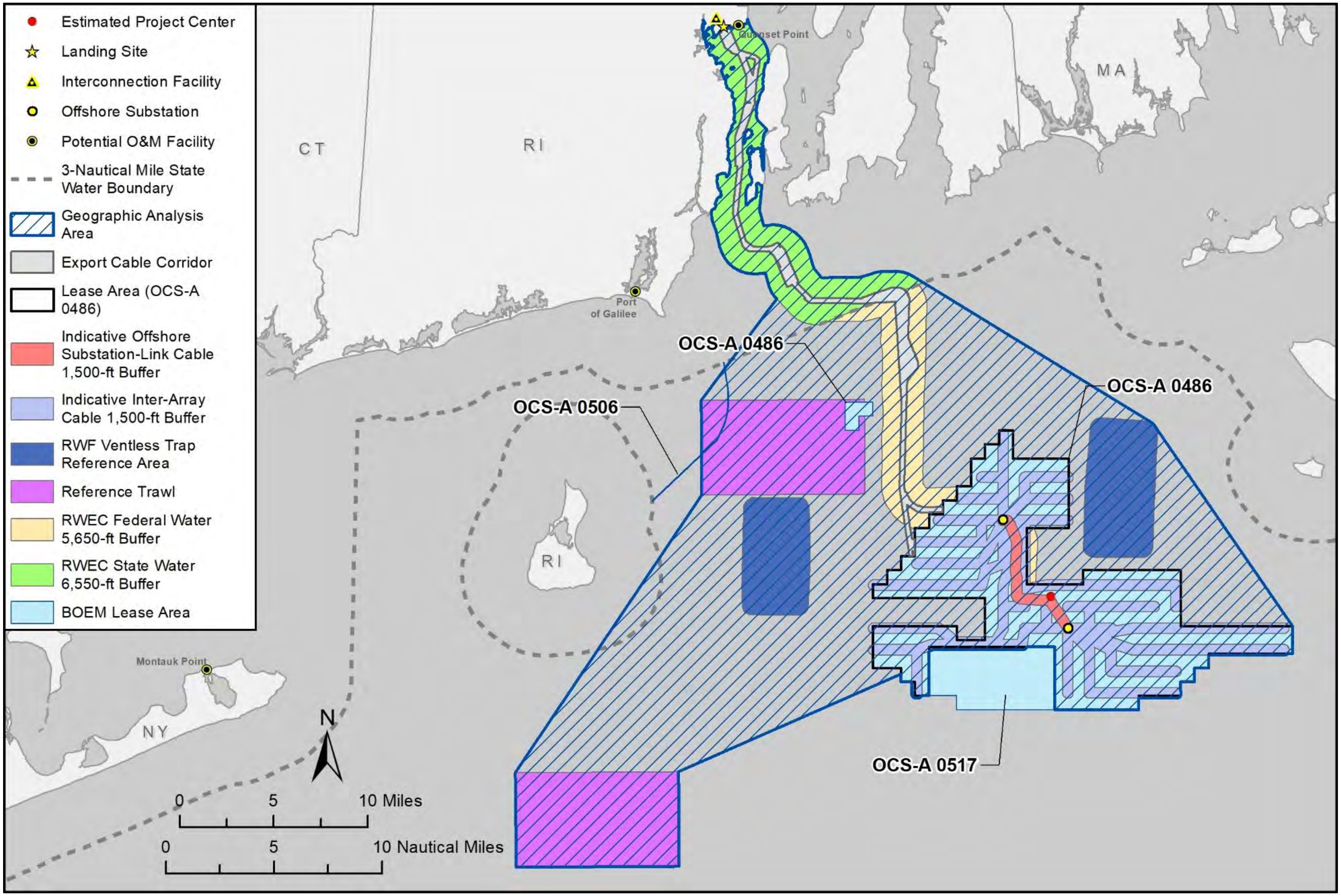

Figure 3.6-1. Geographic analysis area for benthic habitat.

<u>Affected environment:</u> The Mid-Atlantic Regional Council on the Ocean (MARCO) (2019), BOEM (Guida et al. 2017), and Revolution Wind (Fugro 2021) conducted large-scale general benthic habitat mapping within the RWF and along the RWEC corridor. Inspire Environmental (2023) characterized site-specific benthic habitat conditions by combining photographic surveys with side-scan sonar and backscatter data collected by Fugro (2021) to support the EFH analysis. Inspire Environmental (2021a, 2023) has characterized substrate composition using the Coastal and Marine Ecological Classification Standard (CMECS) (Federal Geographic Data Committee [FGDC] 2012) and mapped benthic habitat to support analysis of impacts on living marine resources following NMFS (2021a). The areas mapped by Inspire Environmental (2023) comprise the RWF maximum work area and the RWEC installation corridor. These represent the areas wherein impacts from RWF and RWEC construction and O&M may occur and not the anticipated extent of those impacts. Habitat composition within these areas is presented for the purpose of describing the environmental baseline. The impacts of the Proposed Action and the other action alternatives would be contained entirely within the areas shown.

For the purposes of analysis, the marine substrates of the affected environment are consolidated into three habitat types: 1) large-grained complex habitat, 2) complex habitat, and 3) soft-bottom habitat. These habitat types are based on substrate size and composition and their use by marine organisms. The distribution of these habitat types within the RWF maximum work area and the RWEC installation corridor is displayed in Figures 3.6-2 and 3.6-4, respectively, and summarized in Table 3.6-1. Large-grained complex habitat is composed primarily of hard surfaces in the form of large boulders and bedrock, often in a matrix of finer sediments. Complex habitat comprises a diversity of habitat types, including small boulders; cobbles and coarse gravel; shell hash; substrate matrices composed predominantly of boulders, cobbles, and pebbles mixed with patches of finer material (e.g., pebbles in a sand matrix); and/or submerged aquatic vegetation. Complex habitats provide a mixture of hard surfaces and fine material that provide habitat for many different species. Invertebrate species that encrust or attach themselves to the hard surfaces provided by immobile boulders and cobbles are important components of complex benthic habitat. Soft-bottom benthic habitat is composed of silt, sand, sandy mud, mud, and muddy sand areas and does not include a substantial portion of coarse-grained sediment, although scattered boulders and patches of gravels and small cobbles are commonly present. Boulder fields and scattered boulders are important components of benthic habitat, providing hard surfaces available for colonization by habitat-forming organisms. The distribution of medium-density (246–491 boulders/acre) and low-density (50–245 boulders/acre) boulder fields and scattered surficial boulders (< 50 boulders/acre) within the RWF maximum work area and RWEC installation corridor are shown in Figures 3.6-3 and 3.6-5, respectively.

All seafloor sediments except for bedrock and large boulders are mobile to varying degrees and are continually reshaped by bottom currents (Butman and Moody 1983; Daylander et al. 2012) and biological activity. These processes form features like sandwaves and ripples that are used by many different fish species (Langton et al. 1995). For example, mobile sediment waves form natural depressions and can expose biological structures like amphipod tubes. These features provide refuge from currents and complex cover for small fish and are components of designated EFH for some species, such as red and silver hake. BOEM (2020a) defines ripples as sediment waves less than 1.6 feet high, megaripples are sediment waves between 1.6 and 4.9 feet high, and sandwaves are sediment waves greater than 4.9 feet high. No sandwaves were observed in the RWF maximum work area or RWEC corridor, but ripples and megaripples are common. These features were observed in nearly 100% of soft-bottom habitat and were present in over 90% of large-grained complex and complex habitats (Inspire Environmental 2023).

Table 3.6-1. Proportional Distribution of Benthic Habitat Types within the Revolution Wind Farm Maximum Work Area and Revolution Wind Export Cable Installation Corridor and the Proportional Composition of Mapped Area by Benthic Habitat Type

Project Component	Total Mapped Area (acres)	Large-Grained Complex (%)	Complex (%)	Soft-Bottom (%)	Anthropogenic (%)
RWF maximum work area	58,143	19.1%	30.0%	50.8%	0.0%
RWEC – OCS installation corridor	5,028	0.6%	32.1%	67.2%	0.0%
RWEC – RI installation corridor	5,728	3.1%	14.3%	82.2%	0.5%

3.6.1.2 Invertebrates

Geographic analysis area: The intent of the GAAs used in this EIS is to define a reasonable boundary for assessing the potential effects, including cumulative effects, resulting from the development of an offshore wind energy industry on the Mid-Atlantic OCS. Given this, the GAA for invertebrates considers the effects of the Proposed Action as well as potential effects from other planned or proposed actions. GAAs for marine biological resources are necessarily large because marine populations range broadly and cumulative impacts can be expressed over broad areas. GAAs are not used as a basis for analyzing the direct and indirect effects of the Proposed Action, which represent a subset of these broader effects and expressed over a smaller area. These impacts are analyzed specific to each IPF.

The GAA for invertebrates is shown in Figure 3.13-1. This analysis area is the same for finfish and EFH resources, encompassing the Scotian Shelf, Northeast Shelf, and Southeast Shelf Large Marine Ecosystems, which captures the likely extent of adult and juvenile movement and egg and larval dispersal patterns within U.S. waters for most species in this group. The invertebrate GAA encompasses the extent of potential effects on habitat-forming organisms that comprise an important component of benthic habitat structure. Therefore, while Project-related impacts to benthic habitat composition are restricted to a relatively small geographic area, the GAA for impacts to habitat-forming organisms is necessarily large. Because the GAA for invertebrates is large, the focus of the analysis in this EIS is on those species that are likely to occur in the vicinity of the proposed RWF and RWEC on an at least infrequent basis and could be impacted by Project activities.

Affected environment: For the purposes of the EIS, marine invertebrates are grouped into three categories: 1) pelagic invertebrates, specifically squid and pelagic invertebrate eggs and larvae; 2) benthic invertebrates associated with soft sediments (i.e., soft-bottom benthic habitat); and 3) benthic invertebrates associated with hard surfaces, such as boulders, cobble, and coarse gravel (i.e., complex benthic habitat). Certain invertebrates in the latter two groups comprise and/or form complex structures that provide habitat for fish and other marine organisms and are therefore an important component of benthic habitat structure.

Squid, specifically longfin squid (*Doryteuthis pealeii*) and shortfin squid (*Illex illecebrosus*), are the pelagic invertebrate species likely to occur in the GAA during their juvenile and adult life stages (Cargnelli et al. 1999; Lowman et al. 2021). Squid eggs, most likely longfin squid, were observed at survey locations within the RWF footprint (Inspire Environmental 2021a), indicating that this species spawns in the vicinity. Squid attach their eggs to bottom substrates and use both complex and soft-bottom benthic habitats for spawning. Numerous benthic invertebrate species have pelagic eggs and larvae and rely on currents to disperse their offspring to distant habitats from where spawning occurs (e.g., Chen et al. 2021; McCay et al. 2011; Munroe et al. 2018; Roarty et al. 2020; Zhang et al. 2015). These dispersed eggs and larvae are also a component of EFH as they form part of the prey base for a variety of species during one or more life stages.

Soft-sediment invertebrates create a permanent or semipermanent home in the bed sediments. Most of these invertebrates possess specialized organs for burrowing, digging, embedding, tube building, anchoring, or locomotion in soft substrates. Some species are capable of moving slowly over the bed surface on soft substrates, but these species are generally not able to travel across hard substrates for long periods. Soft-sediment invertebrates include various types of annelid worms (oligochaetes and polychaetes), flatworms (Platyhelminthes), and nematodes (Nematoda); crustaceans, such as burrowing amphipods (Amphipoda), mysids (Mysida), copepods (Copepoda), and crabs (Brachyura); echinoderms, including sand dollars (Clypeasteroida), starfish (Asteroidea), and sea urchins (Echinoidea); and bivalve mollusks (Pelecypoda) (FGDC 2012; Inspire Environmental 2019). Economically important species, including Atlantic sea scallop (*Placopecten magellanicus*), bay scallop (*Argopecten irradians*), horseshoe crab (*Limulus polyphemus*), Atlantic surfclam (*Spisula solidissima*), squid, and ocean quahog (*Arctica islandica*), are associated with soft sediments on the Mid-Atlantic OCS.

Invertebrates associated with hard substrates are found on the different types of complex habitat defined in Section 3.6.1.1 (i.e., large-grained complex and complex habitats). This group includes a diversity of species, such as members that firmly attach to hard surfaces or that crawl, rest, and/or cling to the surface of and/or shelter in the interstitial spaces between cobbles and boulders. Attached invertebrates use structures like pedal discs, cement, and byssal threads to attach to hard surfaces. Nonattached organisms use feet, claws, appendages, spines, suction, negative buoyancy, or other means to stay in contact with the hard substrate and may or may not be capable of slow movement over the surface. Examples of attached invertebrates include sea anemones, barnacles, corals, sponges, hydroids, bryozoans, mussels, and oysters. Examples of non-attached organisms include crabs, small shrimp, amphipods, starfish, and sea urchins (FGDC 2012; Inspire Environmental 2021a). Some economically important invertebrate species—notably, American lobster (*Homarus americanus*; also referred to as lobster)—are associated with hard substrates. Both soft-sediment and hard-surface invertebrate species are likely to be present within complex benthic habitat, with the former using patches of soft substrate commonly found in this habitat type. Soft-sediment invertebrates would be largely dominant in soft-bottom habitats, although some hard-surface species may occur on scattered hard surfaces where they are available.

Several commercially important invertebrate species, such as lobster, Atlantic sea scallop, longfin inshore squid and shortfin squid, and ocean quahog, occur within the RWF and RWEC portions of the GAA (Inspire Environmental 2021b). Invertebrates are also targeted by recreational fisheries, typically close (within 1 mile) to shore (see Section 3.18). Many invertebrate species found in nearshore marine and estuarine environments were historically used by the region's Native American tribes (Bennett 1955) and are currently targeted tribal subsistence fisheries (BOEM 2020b).

The affected environment for invertebrates is influenced by commercial and recreational harvest of certain invertebrate species (e.g., squid, lobster), benthic habitat modification and disturbance by activities like vessel anchoring and bottom-disturbing fishing methods, and regional shifts in biological community structure caused by climate change trends. Some commercial fishing methods, specifically scallop and clam dredges and bottom trawling, are a source of chronic disturbance of seafloor habitats. Depending on the frequency of disturbance, this type of fishing activity can impact community structure and diversity and limit recovery over long-term periods (BOEM 2023; Grabowski et al. 2014; Henriques et al. 2014; Nilsson and Rosenberg 2003; Rosenberg et al. 2003). The severity and rate of recovery from fishing-related disturbance is variable and dependent on the type of gear used and the nature of the affected benthic habitat.

3.6.2 Environmental Consequences

3.6.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

The analysis presented in this section considers the impacts resulting from the maximum-case scenario under the PDE approach developed by BOEM to support offshore wind project development (Rowe et al. 2017). The maximum-case scenario specifications defined in Appendix D, Table D-1 are PDE parameters used to conduct this analysis. Several Project parameters could change during the development of the final Project configuration, potentially reducing the extent and/or intensity of impacts resulting from the associated IPFs. The design parameters in Table 3.6-2 would result in reduced impacts relative to those generated by the design elements considered under the PDE.

Table 3.6-2. Project Design Parameters That Could Reduce Impacts

Design Parameter	Description
Fewer WTGs could be permitted	This would result in fewer offshore structures and reduced IAC length. This would reduce the extent of short-term to permanent impacts on benthic habitat and invertebrates by reducing the extent of benthic habitat disturbance and suspended sediment deposition impacts from installation of foundations, cables, and scour and cable protection, and associated vessel anchoring activities; reducing the extent and duration of underwater noise impacts from WTG foundation installation; and reducing the extent of reef and hydrodynamic effects resulting from structure presence.
Foundation and cable micrositing	Foundation locations and cable routing could be modified to avoid and minimize certain habitat impacts to the greatest extent practicable within design limits. This would reduce long-term to permanent impacts to benthic habitat and invertebrates by reducing the extent of disturbance in large-grained complex and complex habitats.
The use of a casing pipe method to construct the RWEC sea-to-shore transition	This would eliminate the need for a temporary cofferdam, resulting in less extensive acoustic and vibration impacts than vibratory pile driving to construct a cofferdam (Zeddies 2021).

Design Parameter	Description
The use of a temporary cofferdam for RWEC sea-to-shore transition construction	This would reduce sediment deposition and burial effects on invertebrates.

See Appendix E1 for a summary of IPFs analyzed for benthic habitat and invertebrates across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have a negligible effect are excluded from Chapter 3 and provided in Appendix E, Table E2-3. The duration of impacts disclosed for this resource deviate slightly from general guidelines provided in Section 3.3 (see footnote in Section 3.6.2.2.2). Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component. Where feasible, calculations for specific alternative impacts are provided in Appendix E4, to facilitate reader comparison across alternatives. Table 3.6-3 provides a summary of IPF findings carried forward for analysis in this section. Each alternative analysis discussion consists of the construction and installation phase, the O&M phase, the decommissioning phase, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion. These analyses consider the implementation of all EPMs proposed by Revolution Wind to avoid and minimize impacts to benthic habitat and invertebrates. These EPMs are summarized in Appendix F, Table F-1. Additional EMPs that BOEM could propose, as well as EMPs agreed upon through consultations and agency-to-agency negotiations, are summarized in Appendix F, Tables F-2 and F-3.

A detailed analysis of the Proposed Action is provided following the table. Detailed analysis of other considered action alternatives is also provided below the table if analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component. For benthic resources and invertebrates, onshore Project activities would not result in impacts to marine resources. Therefore, onshore impacts would have no measurable effects on relevant habitats or species and are not evaluated below.

It is important to note that the impact analyses for benthic habitat and invertebrates are necessarily interrelated because habitat-forming invertebrates are an integral component of benthic habitat structure. For example, the tubes formed around burrows created by certain sand- and mud-dwelling invertebrates are commonly exposed by sediment mobility, creating complex three-dimensional cover. Corals, sponges, hydroids, barnacles, and other types of invertebrates that attach to hard substrates like cobbles and boulders similarly create complex cover and habitat. These invertebrate-created features are important components of benthic habitat structure used by a diversity of fish and other organisms. Therefore, many IPFs are discussed only in terms of their potential effects on invertebrates, as short-term or longer duration impacts to benthic habitat structure are the result of effects on habitat-forming invertebrates.

The conclusion section within each alternative analysis discussion includes rationale for the overall effect call determination. The Proposed Action and all other action alternatives would result in **moderate** adverse and **moderate** beneficial impacts on benthic resources and invertebrates in the GAA 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.

Table 3.6-3. Alternative Comparison Summary for Benthic Habitat and Invertebrates

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
Benthic Habitat							
Anchoring and new cable emplacement/ maintenance	**Offshore**: Under the No Action Alternative, the Project would not be constructed and no Project-related vessel anchoring or cable emplacement activities would occur. If no other offshore wind project–related activities occur in the GAA, the impacts of this IPF would be **negligible** adverse. Should future projects include anchoring and cable placement activities within the GAA, **minor** adverse impacts on benthic habitats could result from this IPF.	**Offshore**: Seafloor preparation (boulder relocation) and cable installation activities during construction would impact approximately 246 and 501 acres of large-grained complex and complex habitat, respectively, and 1,297 acres of soft-bottom habitat within the RWF and RWEC construction footprints. This seafloor disturbance would constitute short- to long-term impacts and long-term habitat modification that would constitute a **minor** adverse impact to benthic habitat. The IAC, OSS-link cable, and RWEC would not require routine maintenance, but up to 10% of cable protection could need to be replaced over the life of the Project. Cable protection maintenance and the eventual decommissioning and removal of buried cables would produce direct disturbance of the seafloor, suspended sediment deposition in the surrounding area, and injury and displacement of invertebrates using these habitats. These O&M impacts would be short term in duration and would recover over time without mitigation and would therefore be **minor** adverse. There would be no cumulative impacts from this IPF associated with other planned and foreseeable future wind energy projects. BOEM estimates a total of 3,204 acres of anchoring and mooring-related disturbance and 2,043 acres of cabling-related disturbance for the Proposed Action within the benthic GAA. Short-term disturbance impacts on soft-bottom benthic habitats and associated fish and invertebrate species would be expected to fully recover within 18 to 30 months, whereas impacts in complex benthic habitats could be long term to permanent. Long-term impacts to habitat-forming organisms in complex habitats would require several years to recover full habitat function. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat type. While habitat structure may be altered, habitat composition in the affected areas would recover to functional condition over the life of the Project. Therefore, the Proposed Action when combined with past, present, and reasonably	**Offshore**: See Section 3.6.2.6.1 for construction impact analysis. Anchoring and cable maintenance O&M effects on benthic habitat from Alternatives C through F would be similar to but reduced in extent from the Proposed Action. The distribution of habitat impacts would vary between alternatives, with the two proposed configurations of Alternative C producing the greatest reduction in impacts to large-grained complex and complex habitats. In terms of significance, impacts to benthic habitat would be similar across alternatives: **minor** adverse. Alternatives C through F when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to benthic habitats under all proposed configurations. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Impacts on soft-bottom benthic habitats and associated fish and invertebrate species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take several years to recover to full habitat function.				**Offshore**: See Section 3.6.2.9.1 for construction impact analysis. Anchoring and cable maintenance O&M effects on benthic habitat would be similar to but reduced in extent from the Proposed Action. Alternative G would decrease the estimated extent of benthic impacts by over 940 acres relative to the Proposed Action and would increase the proportional distribution of impacts occurring in soft-bottom habitat from 57.8% to 67.4%. Alternatives G1 through G3 would reduce benthic habitat impacts by an additional 479 to 488 acres relative to the base Alternative G. In terms of significance, impacts to benthic habitat would be similar across alternatives: **minor** adverse. When combined with past, present, and reasonably foreseeable projects, the base configuration of Alternative G and Alternatives G1 through G3 would result in **minor** to **moderate** adverse cumulative impacts to benthic habitats under all proposed configurations. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Impacts on soft-bottom benthic habitats and associated fish and invertebrate species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take several years to recover to full habitat function.

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		foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to benthic habitats.					
Climate change	**Offshore**: Global climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These changes could indirectly affect benthic habitat structure and composition through a variety of mechanisms. For example, changes in freshwater runoff rates and the frequency of large storm events could change the rate of delivery of fine sediments to nearshore environments and sediment transport patterns in the offshore environment. These trends are expected to continue under the No Action Alternative. The severity of impacts on benthic habitat resulting from climate change trends are uncertain but are anticipated to range from **minor** to **moderate** adverse and would be effectively permanent.	**Offshore**: The types of impacts from global climate change trends described for the No Action Alternative would occur under the Proposed Action, but the Proposed Action could also contribute to a long-term net decrease in GHG emissions. This difference may not be measurable but would be expected to help reduce climate change impacts. When combined with other past, present, and reasonably foreseeable actions, climate change trends would result in **moderate** adverse cumulative impacts to benthic habitat.	**Offshore**: The types of impacts from global climate change trends described for the No Action Alternative would occur under Alternatives C through F but, as with the Proposed Action, these alternatives could also contribute to a long-term net decrease in GHG emissions. This difference may not be measurable but would be expected to help reduce climate change impacts. When combined with other past, present, and reasonably foreseeable actions, climate change trends would result in **moderate** adverse cumulative impacts to benthic habitat under all proposed configurations of Alternatives C through F.				**Offshore**: The types of impacts from global climate change trends described for the No Action Alternative would occur under all proposed configurations of Alternative G, but, as with the Proposed Action, these alternatives could also contribute to a long-term net decrease in GHG emissions. This difference may not be measurable but would be expected to help reduce climate change impacts. When combined with other past, present, and reasonably foreseeable actions, climate change trends would result in **moderate** adverse cumulative impacts to benthic habitat under all proposed configurations of Alternative G.
Presence of structures	**Offshore**: Under the No Action Alternative, the Project would not be constructed and no Project-related structures would be placed within the benthic habitat GAA. No associated effects would occur in the GAA and therefore the impacts of this IPF would be **negligible** adverse.	**Offshore**: The installation of 102 offshore structures in the form of monopile foundations with associated scour protection would result in the direct disturbance of benthic habitats. These impacts would be long term in duration, but the affected habitats would develop into functional complex habitat over time as they are colonized by habitat-forming invertebrates. Habitats would recover after structures are decommissioned and removed. Therefore, the presence of structures would result in a long-term **moderate** adverse effect on benthic habitat during construction. During O&M, the Proposed Action would permanently alter benthic habitats within the GAA, generating an array of effects on benthic habitat function. Soft-bottom habitats would be permanently displaced while effects on large-grained complex and complex benthic habitats would range from short term to long term or permanent. Some benthic species could recolonize new hard surfaces within 2 to 4 years while others take up to a decade or more to recover from damage and/or colonize new surfaces like concrete mattresses. This would constitute a long-term	**Offshore**: See Section 3.6.2.6.1 and 3.6.2.6.2 for construction and O&M impacts. Alternatives C through F would result in the installation of 56 to 93 new offshore wind energy structures in the GAA, resulting in the long-term alteration of benthic habitat composition by foundations, scour protection, and cable protection. For comparison, Alternatives C and E would reduce seafloor disturbance during construction by 7% to up to 35%; Alternative D would reduce seafloor disturbance from foundation construction by up to 21.6%; and Alternative E would reduce seafloor disturbance by up to 34%, as compared to the maximum-case scenario for the Proposed Action. Implementation of Alternative F in conjunction with Alternatives C, D, and E would further reduce seafloor disturbance for these alternatives by up to 8%, 21.5%, and 8%, respectively. The resulting impacts would be limited in extent to the area of influence around each foundation but would be long term in duration. BOEM anticipates that hydrodynamic impacts of Alternatives C, D, and E would be broadly similar to those under the Proposed Action, with some variation in distribution and extent due to differences in the number and location of foundations. However, Alternative C and corresponding configurations of Alternative F would avoid impacts to sensitive large-grained complex habitats in the center of the Lease Area to a greater extent than Alternatives D and E. Hydrodynamic effects from Alternative F would be similar to those from the selected alternative configuration but could vary slightly due to differences in WTG rotor height. On this basis, reef and hydrodynamic effects from the presence of structures under Alternatives C through F would contribute to cumulative long-term effects on benthic habitat that would range from **moderate** beneficial to **minor** to **moderate** adverse.				**Offshore**: See Sections 3.6.2.4.1 and 3.6.2.4.2 for construction and O&M impacts. The base configuration of Alternative G would result in the installation of 67 new offshore wind energy structures in the GAA, resulting in the long-term alteration of benthic habitat composition by foundations, scour protection, and cable protection. Alternatives G1 through G3 would each result in the installation of 65 WTG and two OSS structures. The base configuration of Alternative G and Alternatives G1 through G3 would reduce seafloor disturbance from foundation construction by 21% to 34%, respectively, as compared to the maximum-case scenario for the Proposed Action. The resulting impacts would be limited in extent to the area of influence around each foundation but would be long term in duration. BOEM anticipates that hydrodynamic impacts of Alternative G would be broadly similar to those under

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		reduction in benthic habitat function. In contrast, biologically productive reef effects would likely develop within 3 to 4 years after construction, continuing to mature over the life of the Project. These effects could be **minor** to **moderate** adverse or **moderate** beneficial, depending on how benthic habitat change influences the broader biological community. There would be no cumulative impacts from this IPF associated with other planned and foreseeable future wind energy projects. The alterations in substrate composition resulting from the Proposed Action described above would be limited to the area of influence around each foundation but would be long term in duration, as changes in substrate composition from the accumulation of shell hash and altered substrate chemistry would continue to persist after the structures are removed during decommissioning. As such, reef effects from the presence of structures would result in cumulative long-term effects on benthic habitat and would range from **moderate** beneficial to **minor** to **moderate** adverse.					the Proposed Action, with some variation in distribution and extent due to differences in the number and location of foundations. As such, reef and hydrodynamic effects from the presence of structures under Alternative G would contribute to cumulative long-term effects on benthic habitat that would range from **moderate** beneficial to **minor** to **moderate** adverse.
Invertebrates							
Accidental releases and discharges	**Offshore**: Offshore wind energy development could result in the accidental release of water quality contaminants or trash/debris, which could theoretically lead to an increase in debris and pollution in the invertebrate GAA. However, the combined impacts on invertebrate resources (mortality, decreased fitness, disease) from accidental releases and discharges are expected to be minimal, localized, and short term due to the likely limited extent and duration of a release. On this basis, the effects of this IPF on invertebrates under the No Action Alternative would be **negligible** adverse.	**Offshore**: BOEM prohibits the discharge or disposal of solid debris into offshore waters during any activity associated with the construction and operations of offshore energy facilities (30 CFR 250.300). The USCG similarly prohibits the dumping of environmentally damaging trash or debris (MARPOL, Annex V, Public Law 100–220 (101 Stat. 1458)). Given these restrictions, the risk to invertebrates from trash and debris from the Project, including habitat-forming invertebrates that contribute to benthic habitat structure, is **negligible** adverse. In the unlikely event that accidental spills should occur, adverse impacts to benthic habitats could range from **minor** to **moderate** adverse in significance depending on the size of the spill and the nature of the materials involved. When combined with other offshore wind projects, up to approximately 34 million gallons of coolants, fuels, oils, and lubricants could cumulatively be stored within WTGs and OSSs in the invertebrate GAA. All vessels associated with the Proposed	**Offshore**: Given restrictions on the discharge or disposal of solid debris, as described for the Proposed Action, effects on invertebrates and on benthic habitat structure through impacts on habitat-forming invertebrates from trash and debris under Alternatives C through F would be **negligible** adverse. The Project would follow strict oil spill prevention and response procedures during all phases, effectively avoiding the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. In the unlikely event that an unforeseen accident results in a high-volume spill, **minor** to **moderate** adverse effects on invertebrates and on benthic habitat structure through impacts on habitat-forming invertebrates could potentially result. Those impacts could range from short term to long term in duration, depending on the size of the accident, the nature of the materials involved, and the type and location of habitat impacts. Alternatives C through F could slightly reduce total chemical uses relative to the Proposed Action, but this effect would be small in comparison to projected chemical use on the Mid-Atlantic OCS. All future offshore energy development projects would comply with BOEM and USCG regulations that prohibit dumping of trash and debris and require measures to avoid and minimize accidental spills. This would minimize, but not completely eliminate the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, **minor** to **moderate** adverse cumulative effects on invertebrates could potentially result.				**Offshore**: Given restrictions on the discharge or disposal of solid debris, as described for the Proposed Action, effects on invertebrates and benthic habitat structure through impacts on habitat-forming invertebrates from trash and debris would be the same under all configurations of Alternative G as for Alternatives C through F: **negligible** adverse. In the unlikely event that an unforeseen accident results in a high-volume spill, **minor** to **moderate** adverse effects on invertebrates could result under the same rationale presented for Alternatives C through F. Alternative G could slightly reduce total chemical uses relative to the Proposed Action, but this effect would be small in comparison to projected chemical use on the Mid-Atlantic OCS. Based on the same rationale presented for Alternatives C through F, the risk of large-scale,

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		Action and other offshore wind projects would comply with USCG requirements for the prevention and control of oil and fuel spills. However, higher volume spills of toxic materials could occur due to unanticipated events, such as a vessel allision with a WTG foundation. When low-probability, unanticipated events are considered, the Proposed Action when combined with other past, present, and reasonably foreseeable projects, poses a potential for **minor** to **moderate** adverse cumulative impacts on invertebrates that could range from short term to long term in duration.					environmentally damaging spills under reasonably foreseeable circumstances is very low but cannot be completely discounted. In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, **minor** to **moderate** adverse cumulative effects on invertebrates could potentially result.
Anchoring and new cable emplacement/ maintenance	**Offshore**: Offshore energy facility construction would involve direct disturbance of the seafloor, leading to direct impacts on invertebrates. In general, however, these effects would be localized to the disturbance footprint and vicinity. The severity of these effects would vary depending on the species and life stage sensitivity to specific stressors that extend into the area, resulting in **minor** adverse impacts on invertebrates.	**Offshore**: Seafloor preparation, cable trenching, dredging, vessel anchoring, and short-term bed disturbance at the sea-to-shore transition site would directly disturb soft-bottom benthic habitat by crushing and displacing epifaunal organisms on the bed surface and liquifying sand and mud sediments from the bed surface to depths of up to 6 feet, killing and displacing benthic infauna within the cable path. The Proposed Action includes several EPMs, listed in Table F-1 in Appendix F, that would limit, but not completely avoid, crushing, burial, and entrainment impacts on invertebrates. While some impacts would be unavoidable, the affected habitats would recover naturally over time, and impacts on invertebrates are unlikely to be measurable at the population level. Therefore, adverse impacts to invertebrates from this IPF during construction would be **minor** adverse. Up to 10% of cable protection could need to be replaced over the life of the Project. The IAC, OSS-link cable, and RWEC would also be removed from the seafloor during Project decommissioning. Resulting effects from O&M and decommissioning would be short term in duration, and similar in nature but lesser in magnitude than those resulting from Project construction. Therefore, these adverse effects would be **minor** adverse. BOEM estimates a cumulative total of 11,631 acres of anchoring and mooring-related disturbance and 105,390 acres of cabling-related disturbance for the Proposed Action plus all other future offshore wind projects within the benthic GAA. The duration and magnitude of these effects would vary depending on the types of habitats impacted.	Alternatives C through F would reduce the total length of IAC and anchoring relative to the Proposed Action, meaning that the total amount of construction- and maintenance-related impacts on invertebrates would decrease commensurately. This decrease would be noticeable in comparison to the Proposed Action. Impacts from decommissioning and removal of the IAC, including seafloor disturbance and TSS effects, would likewise be reduced relative to the Proposed Action. The resulting adverse effects from O&M and decommissioning would be similar in nature but lesser in magnitude than those resulting from Project construction and would therefore be **minor** adverse. The reduction in total IAC length under Alternatives C through F and reduced O&M anchoring requirements for structure maintenance would noticeably decrease the cumulative impact acreage across projects relative to the Proposed Action, but the nature, duration, and general scope of effects would otherwise be similar. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Impacts on soft-bottom benthic habitats and associated fish and invertebrate species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take up to a decade or more to fully recover. Therefore, Alternatives C through F when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to benthic habitats and habitat-forming invertebrates.				The base configuration of Alternative G would reduce the total length of IAC from approximately 155.3 miles to 116.1 miles, and the total number of installed offshore wind structures from 102 to 82. This would result in a commensurate reduction in associated cable installation impacts and anchoring requirements for foundation installation relative to the Proposed Action. The distribution of impacts by habitat type would shift toward soft-bottom habitat and associated invertebrate species. Alternatives G1 through G3 would reduce IAC length by an additional 9.9 to 11.5 miles relative to the Proposed Action and would decrease the total number of structures to 67. As with Alternatives C through F, this would reduce the related extent of construction- and maintenance-related impacts on invertebrates. Similarly, Alternative G would result in fewer offshore wind structures and a commensurate reduction in maintenance-related anchoring requirements relative to the Proposed Action. Like Alternatives C through F, Alternative G would noticeably decrease the cumulative impact acreage across projects relative to the Proposed Action, but the nature, duration, and general scope of effects would otherwise be similar. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Impacts on soft-bottom benthic habitats and associated fish and invertebrate species

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		Impacts on soft-bottom benthic habitats and associated fish and invertebrate species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take up to a decade or more to fully recover. Therefore, the Proposed Action when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts.					would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take up to a decade or more to fully recover. Therefore, Alternative G when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to benthic habitats and habitat-forming invertebrates.
Climate change	**Offshore**: Global climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These changes have affected habitat suitability for the invertebrate community of the GAA. For example, several invertebrate species are shifting in distribution to the northeast, farther from shore and into deeper waters, in response to an overall increase in water temperatures and an increasing frequency of marine heat waves (NOAA 2021). These trends are expected to continue under the No Action Alternative. The intensity of adverse impacts resulting from climate change trends are uncertain but are anticipated to be **minor** to **moderate** adverse**.**	**Offshore**: Global climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These changes have affected habitat suitability for many invertebrates within the GAA. The intensity of climate change cumulative impacts on invertebrates are uncertain and are likely to vary considerably between species, resulting in **moderate** adverse effects.	**Offshore**: Climate change–related impacts to invertebrates under Alternatives C through F would be the same as those described for the Proposed Action. Ongoing trends associated with climate change, including increases in water temperature, ocean acidification, changes in runoff and circulation patterns, and species range shifts, are expected to continue. The intensity of climate change cumulative impacts on invertebrates is uncertain and is likely to vary considerably between species, resulting in **moderate** adverse effects.				**Offshore**: Climate change–related impacts to invertebrates under Alternative G would be the same as those described for the Proposed Action. Ongoing trends associated with climate change, including increases in water temperature, ocean acidification, changes in runoff and circulation patterns, and species range shifts, are expected to continue. The intensity of climate change cumulative impacts on invertebrates is uncertain and is likely to vary considerably between species, resulting in **moderate** adverse effects.
EMF	**Offshore**: Under the No Action Alternative, up to 13,469 miles of cable would be added in the invertebrate GAA, producing EMF effects in the immediate vicinity of each cable during operations. BOEM would require these future submarine power cables to have appropriate shielding and burial depth to minimize potential EMF effects from cable operation. Accordingly, long-term effects from Project-related EMFs on invertebrates that live in or directly on the seafloor could range from **negligible** to **minor** adverse for projects using HVAC transmission.	**Offshore**: Construction impacts would not result in EMF impacts. Operation of the IAC, OSS-link cable, and RWEC would generate EMF and substrate heating effects, altering the environment for benthic invertebrates and other organisms associated with those habitats. The evidence for EMF effects on invertebrates is equivocal, varying considerably between species and based on the type and strength of EMF source (Albert et al. 2020; Hutchison et al. 2020a, 2020b). Given this uncertainty, the potential permanent effects from Project-related EMFs on invertebrates that live in or directly on the seafloor could range from **negligible** to **minor** adverse. BOEM anticipates that future offshore wind energy projects in the GAA would use HVAC (versus HVDC) transmission and apply similar design measures to those included in the Proposed Action avoid and minimize EMF effects on the environment. While	**Offshore**: See Section 3.6.2.7.2 for analysis of O&M impacts. Cable installation would not result in EMF impacts. Alternatives C through F would generate EMF effects of varying intensity along the IAC, OSS-link cable, and RWEC length. These EMF effects would combine with those generated by the 13,717 miles of new and existing transmission cables from the other new offshore wind facilities planned on the Mid-Atlantic OCS as well as other existing transmission cables. These cumulative effects would be similar in nature to those described for the No Action Alternative but would occur over a larger area, as determined by the broader project footprint. Cumulative impacts to invertebrates would therefore range from **negligible** to **minor** adverse.				**Offshore**: See Section 3.6.2.9.2 for analysis of O&M impacts. Cable installation would not result in EMF impacts. Alternative G would generate EMF effects of varying intensity along the IAC, OSS-link cable, and RWEC length. These EMF effects would combine with those generated by the 13,717 miles of new and existing transmission cables from the other new offshore wind facilities planned on the Mid-Atlantic OCS as well as other existing transmission cables. These cumulative effects would be similar in nature to those described for the No Action Alternative but would occur over a larger area, as determined by the broader project footprint. Cumulative impacts to invertebrates would therefore range from **negligible** to **minor** adverse.

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		uncertainties remain, cumulative adverse impacts to invertebrates from EMF and substrate heating effects are likely to be **minor** adverse**.**					
Light	**Offshore**: Artificial light can attract mobile invertebrates and can influence biological functions (e.g., spawning) that are triggered by changes in daily and seasonal daylight cycles (Davies et al. 2015; McConnell et al. 2010). BOEM has issued guidance for avoiding and minimizing artificial lighting impacts from offshore energy facilities and associated construction vessels (BOEM 2021a; Orr et al. 2013) and has concluded that adherence to these measures should effectively avoid adverse effects on invertebrates. Given the minimal and localized nature of lighting effects anticipated under this guidance, the related effects from proposed future activities on invertebrates, including habitat-forming invertebrates that contribute to benthic habitat structure, are likely to be **negligible** adverse.	**Offshore**: Lights would be required on offshore platforms and structures, vessels, and construction equipment during construction and O&M of the RWF. Construction vessel lighting has the potential to affect invertebrates. Many invertebrates are attracted to and/or respond behaviorally to light in the environment, and exposure to artificial light can alter biological responses (e.g., spawning) that are triggered by changes in day length and light intensity (Davies et al. 2015; McConnell et al. 2010). Consistent with BOEM guidance (BOEM 2021a; Orr et al. 2013), construction vessels would implement lighting design and operational measures to eliminate or reduce lighting impacts on the aquatic environment. Although individual invertebrates could detect light from vessels and could exhibit behavioral responses (e.g., squid being attracted to the lights), these impacts are not expected to measurably affect invertebrates at population levels because of the limited area of impact at any given time and the limited duration of Project activities. Any resulting adverse impacts on invertebrates would be short term in duration and biologically insignificant, and therefore **negligible** adverse**.** All future projects would also be expected to comply with BOEM design guidance for avoiding and minimizing adverse lighting impacts on the environment. Therefore, the cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable future activities would be similar to those impacts described under the No Action Alternative: **negligible** adverse.	**Offshore**: Alternatives C through F would reduce the total length of IAC and the number of offshore wind energy structures relative to the Proposed Action. This would result in a commensurate reduction in the duration of construction vessel activity and related short-term lighting impacts. Construction vessels would implement the same lighting design and operational measures to reduce lighting impacts as under the Proposed Action. The level of impact would therefore be similar in nature but reduced in extent relative to the Proposed Action: **negligible** adverse. Artificial light from structures during Project operations and from vessels used for O&M and decommissioning could affect invertebrates, including habitat-forming invertebrates that contribute to benthic habitat structure. Given the minimal and localized nature of anticipated lighting effects, however, any indirect effects on invertebrates from light generated during O&M and decommissioning are expected to be **negligible** adverse. BOEM estimates a cumulative total of 3,146 to 3,183 offshore WTGs and OSS foundations for the Project plus all other future offshore wind projects in the invertebrate GAA. The RWF and all future projects would be expected to comply with BOEM design guidance for avoiding and minimizing adverse lighting impacts on the environment. Therefore, the cumulative impacts associated with Alternatives C through F when combined with past, present, and reasonably foreseeable activities would **negligible** adverse, mostly attributable to existing, ongoing activities.				**Offshore**: Like Alternatives C through F, Alternative G would reduce the total length of IAC and the number of offshore wind energy structures relative to the Proposed Action. Based on the same rationale presented for Alternatives C through F, lighting impacts to invertebrates from construction of Alternative G would be similar in nature but reduced in extent relative to the Proposed Action: **negligible** adverse. As with Alternatives C through F, lighting effects under Alternative G are anticipated to be minimal and localized. Therefore, any indirect effects on invertebrates from light generated during O&M and decommissioning are expected to be **negligible** adverse. BOEM estimates a cumulative total of 3,155 offshore WTGs and OSS foundations for Alternative G, plus all other future offshore wind projects in the invertebrate GAA. RWF and all future projects would be expected to comply with BOEM design guidance for avoiding and minimizing adverse lighting impacts on the environment. Therefore, the cumulative impacts associated with Alternative G when combined with past, present, and reasonably foreseeable activities would be **negligible** adverse, mostly attributable to existing, ongoing activities.
Noise	**Offshore**: Underwater noise impacts from future wind energy development would likely result in short-term localized effects on some invertebrate species in immediate proximity to intense sound sources like pile driving. These effects would end when construction is complete. While individual invertebrates could be harmed by noise impacts, potentially	**Offshore**: Construction-related sources of sound pressure and vibration that could affect invertebrates are impact and vibratory pile driving, and, potentially, unexploded ordnance (UXO) detonation. Particle motion effects from pile driving would be limited to short-term behavioral responses, most likely lasting for the duration of the noise impact and limited periods (minutes to hours) following exposure. Particle motion effects	**Offshore**: See Section 3.6.2.7.1 for analysis of construction impacts. Underwater noise effects on invertebrates resulting from O&M and decommissioning of Alternatives C through F would be similar in magnitude but reduced in extent relative to those described for the Proposed Action. Noise impacts on invertebrates are expected to be limited to short-term behavioral effects on individuals within tens of feet of each sound source and therefore **negligible** to **minor** adverse. Alternatives C through F would generate underwater noise effects similar to those described above for the Proposed Action but over an noticeably smaller area. These effects would combine with similar effects resulting from the construction, O&M, and decommissioning of				**Offshore**: See Section 3.6.2.9.1 for analysis of construction impacts. Underwater noise effects on invertebrates resulting from O&M and decommissioning of Alternative G would be similar in magnitude but reduced in extent relative to those described for the Proposed Action, commensurate with the number of operational WTGs under each

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	harmful impacts would be limited in extent and population-level effects would likely be unmeasurable. Underwater noise from the operation of individual wind farms would last for the life of each project. However, the resulting noise effects are not likely to produce measurable impacts on individual invertebrates. On this basis, noise effects on invertebrates from future wind energy development in the GAA are likely to be **negligible** to **minor** adverse.	from UXO detonation could result in mortality of organisms on or immediately adjacent to the munition, and short-term behavioral responses at greater distance. While mortality-level effects could occur, construction-related adverse impacts are likely to be **minor** overall because 1) the areas of effect are small relative to the available habitat, and 2) the loss of individuals would likely be insignificant relative to natural mortality rates for planktonic eggs and larvae, which can range from 1% to 10% per day or higher (White et al. 2014). The RWF WTGs would generate operational noise effects throughout the life of the Project, ending when the Project is decommissioned. Invertebrates lack specialized hearing organs and cannot sense sound pressure in the same way as fish and other vertebrates. Invertebrates can sense sound as particle motion, but particle motion effects dissipate rapidly and are usually undetectable within a few feet of the source. The rapid development of diverse invertebrate communities on operational wind farms worldwide indicates that operational noise has little if any effect on benthic invertebrates. Certain invertebrate species, specifically squid and other cephalopods, may be more sensitive to sound. Although, recent studies of longfin squid have indicated pile driving noise elicits only short-term behavioral responses (i.e., rapid habituation) and does not interrupt reproductive behaviors, such as mate guarding (Cones et al. 2022a, 2022b; Steen 2022, 2023). Operational noise levels likely to be generated by the RWF are not currently known but are likely to be higher than Block Island Wind Farm. Modeling of larger WTG designs suggests that operational noise could approach levels associated with hearing injury in cephalopods, but insufficient information is available to make a definitive conclusion. Collectively, this information indicates that operational noise effects on invertebrates would be **negligible** to **minor** adverse. Likewise, cumulative effects on invertebrates resulting from underwater noise are also likely to be **minor** adverse.	other planned offshore wind projects on the Mid-Atlantic OCS. Invertebrates near impact and vibratory pile-driving activities could be temporarily disturbed by vibration effects, but any such effects would be short term in duration and are unlikely to have a measurable effect on any invertebrate population at the scale of the GAA. On this basis, cumulative effects on invertebrates resulting from underwater noise caused by Alternatives C through F are likely to be **negligible** to **minor** adverse.				configuration. Noise impacts on invertebrates are expected to be limited to short-term behavioral effects on individuals within tens of feet of each sound source and therefore **negligible** to **minor** adverse. As with Alternatives C through F, Alternative G would generate underwater noise effects similar to those described for the Proposed Action but over an noticeably smaller area. These effects would combine with similar effects resulting from the construction, O&M, and decommissioning of other planned offshore wind projects on the Mid-Atlantic OCS. Invertebrates near impact and vibratory pile-driving activities could be temporarily disturbed by vibration effects, but any such effects would be short term in duration and are unlikely to have a measurable effect on any invertebrate population at the scale of the GAA. On this basis, cumulative effects on invertebrates resulting from underwater noise caused by Alternative G are likely to be **negligible** to **minor** adverse.
Bycatch	**Offshore**: A range of monitoring activities has been proposed to evaluate the short-	**Offshore**: The FRMP would result in impacts to individual invertebrates, but the extent of habitat	**Offshore**: The same FRMP included under the Proposed Action or a similar plan with modifications would be implemented under Alternatives C through F. This would result in direct				**Offshore**: The same FRMP included under the Proposed Action, or a similar plan with

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	term and long-term effects of existing and planned offshore wind development on biological resources and are also likely for future wind energy projects on the OCS. Some of these monitoring activities are likely to affect invertebrates. For example, the South Fork Wind Fisheries Research and Monitoring Plan (SFW and Inspire Environmental 2020) includes both direct sampling of invertebrates and the potential for bycatch of invertebrates and/or damage to habitat-forming invertebrates by sample collection gear. Research and monitoring activities related to offshore wind would not necessarily result in an increase in bycatch-related impacts on invertebrates, although the distribution of those impacts could change. As such, any bycatch-related impacts on invertebrates would be **negligible** to **minor** adverse and short term in duration.	disturbance and number of organisms affected would be small in comparison to the baseline level of impacts from commercial fisheries and would not measurably impact the viability of any species at the population level. As such, habitat impacts from FRMP implementation would likely be short term in duration. The intensity and duration of impacts anticipated from FRMP implementation would constitute a **minor** adverse effect on invertebrates. Other planned and potential future offshore wind energy projects have or will likely implement similar monitoring plans that employ similar sampling methods using commercial fishing gear. These monitoring methods would result in intentional and bycatch mortality of invertebrates and could also result in unintentional damage to habitat-forming invertebrates. As such, cumulative impacts from bycatch associated with monitoring activities under the Proposed Action in combination with other planned and future offshore wind projects would be **negligible** to **minor** adverse, with the impacts ranging from short term to long term in duration.	sampling and incidental bycatch mortality of invertebrates as well as incidental damage to habitat-forming-invertebrates by sampling gear that contacts the seafloor. The extent of habitat and number of organisms affected would be small in comparison to the baseline level of impacts from commercial fisheries and would not measurably impact the viability of any invertebrate species at the population level. However, the timing and distribution of impacts may change. As such, Alternatives C through F would result in short-term bycatch impacts on invertebrates that are limited to a small number of individuals. This would therefore constitute a short-term **mino**r adverse effect on invertebrates, including habitat-forming species that contribute to benthic habitat structure. Like the Proposed Action, O&M under Alternatives C through F would include inspection of offshore structures and removal of derelict fishing gear and other accumulated debris. This would provide a mechanism for removing potential sources of bycatch mortality for invertebrates from the environment. This would constitute a long-term **minor** beneficial effect on invertebrates. Other planned and potential future offshore wind energy projects have or will likely implement similar monitoring plans that employ similar sampling methods using commercial fishing gear. This would result in cumulative impacts to invertebrates from sampling and bycatch mortality and incidental damage to habitat-forming organisms from monitoring activities in the GAA. Those effects cumulative would be **negligible** to **minor** adverse, ranging from short term to long term in duration.				modifications, would be implemented under all potential configurations of Alternative G. Under the same rationale presented for Alternatives C through F, Alternative G would result in short-term **minor** adverse effects on invertebrates, including habitat-forming species that contribute to benthic habitat structure. Like the Proposed Action, O&M under Alternative G would include inspection of offshore structures and removal of derelict fishing gear and other accumulated debris. This would provide a mechanism for removing potential sources of bycatch mortality for invertebrates from the environment. This would constitute a long-term **minor** beneficial effect on invertebrates. Other planned and potential future offshore wind energy projects have or will likely implement similar monitoring plans that employ similar sampling methods using commercial fishing gear. This would result in cumulative impacts to invertebrates from sampling and bycatch mortality and incidental damage to habitat-forming organisms from monitoring activities in the GAA. Those effects cumulatively would be **negligible** to **minor** adverse, ranging from short term to long term in duration.
Presence of structures	**Offshore**: The future addition of up to 3,008 new WTG and OSS foundations in the invertebrate GAA could result in artificial reef effects that influence invertebrate community structure within and in proximity to the project footprints. Impacts to invertebrates could range from **moderate** beneficial for organisms associated with hard surfaces to **minor** adverse and **minor** beneficial for organisms associated with soft-bottom habitat. While hydrodynamic impacts on invertebrates are likely to vary between species, localized changes in larval settlement patterns in the absence of	**Offshore**: Invertebrates within the benthic disturbance footprints for foundation installation could be exposed to crushing and burial effects, but the number of individuals affected would be insignificant relative to the size of the population and the resource would recover completely without additional mitigation. The time required for recovery would vary depending on the type of habitats affected, ranging from short term for invertebrates found in soft-bottom habitats to long term for invertebrates associated with large-grained complex and complex habitats. Therefore, adverse effects to invertebrates from construction of structures would be **minor** adverse**.**	**Offshore**: Invertebrates within the respective footprints for Alternatives C through F would be exposed to crushing and burial effects similar in nature but reduced in extent relative to those described for the Proposed Action due to a smaller number of WTGs. For comparison, Alternatives C and E would reduce seafloor disturbance during construction by up to 35%; Alternative D would reduce seafloor disturbance by up to 21.5%; and Alternative F would reduce seafloor disturbance by up to 43%, as compared to the maximum-case scenario for the Proposed Action. Alternative F would produce a similar reduction in seafloor disturbance to the selected configuration from Alternatives C through E. Therefore, the resulting effects from this IPF would similarly range from **negligible** to **minor** adverse during construction. During O&M, Alternatives C through F would produce similar hydrodynamic and reef effects on invertebrates to those described for the Proposed Action, but those effects would be reduced in extent because fewer structures would be installed. Reef and hydrodynamic effects would be distributed differently (see Table 3.6-17, Table 3.6-18, and Table 3.6-19). While the extent of reef and hydrodynamic effects would vary between alternatives, the impacts to invertebrates would be of the same nature, general scale, and magnitude as those described for the				**Offshore**: Invertebrates within the respective footprints for Alternative G would be exposed to crushing and burial effects similar in nature but reduced in extent relative to those described for the Proposed Action due to fewer WTGs being installed. The base Alternative G and Alternatives G1 through G3 would reduce the foundation construction footprint by 21% and 34% compared to the Proposed Action, respectively. The distribution of impacts would shift substantively toward soft-bottom habitats (64.1% to 69.7% under Alternative G and Alternatives G1 to G3 versus 51.3% under the Proposed

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	population-level effects would constitute a **minor** adverse impact on this resource.	On balance, the effects of foundation and scour protection presence on invertebrates are likely to range from **minor** to **moderate** adverse to **moderate** beneficial in terms of the overall O&M impact, varying by species. Concrete mattresses used for cable protection may have to reside in the environment for some time before they provide suitable invertebrate habitat, which would constitute a long-term **minor** adverse impact depending on the amount of cable protection used. O&M would also include regular inspections of offshore structures and opportunistic removal of derelict fishing gear and other accumulated debris over the life of the Project. Derelict gear and debris removal from structures would constitute a long-term **minor** beneficial effect. BOEM estimates the Proposed Action and other planned future projects will result in the development of 3,190 WTG and OSS foundations within the invertebrate GAA. Depending on how they are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential impacts of these broader cumulative effects on invertebrates in general. However, cumulative effects could be beneficial or adverse, varying by species, and would likely range from **minor** adverse and beneficial to **moderate** adverse and beneficial in terms of overall impact.	Proposed Action. These effects would therefore range from **minor** adverse to **moderate** beneficial, with some invertebrate species experiencing a permanent loss of suitable habitat while other species would gain habitat and otherwise benefit from increased biological productivity. BOEM estimates the Proposed Action and other planned future projects will result in the development of up to 3,146 to 3,183 foundations within the invertebrate GAA. Depending on how they are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential biological significance of broader cumulative effects on invertebrates. However, BOEM anticipates that cumulative effects could vary by species, and would likely range from **minor** adverse and beneficial to **moderate** adverse and beneficial.				Action). While the extent and distribution of foundation construction impacts to invertebrates would decrease and shift under Alternative G, the overall impacts of this IPF would be similar to those resulting from the Proposed Action: **negligible** to **minor** adverse. During O&M, Alternative G would produce similar hydrodynamic and reef effects on invertebrates to those described for the Proposed Action, but those effects would be reduced in extent because fewer structures would be installed. Reef and hydrodynamic effects would be distributed differently (see Table 3.6-17, Table 3.6-18, and Table 3.6-19). While the extent of reef and hydrodynamic effects would vary between alternatives, the impacts to invertebrates would be of the same nature, general scale, and magnitude as those described for the Proposed Action. These effects would therefore range from **minor** adverse and beneficial to **moderate** adverse and beneficial, with some invertebrate species experiencing a permanent loss of suitable habitat while other species would gain habitat and otherwise benefit from increased biological productivity. BOEM estimates Alternative G and other planned future projects will result in the development of 3,155 foundations within the invertebrate GAA. Under the same rationale presented for Alternatives C through F, BOEM anticipates that cumulative effects from Alternative G would likely range from **minor** adverse and beneficial to **moderate** adverse and beneficial, varying by species.
Sediment deposition and burial	**Offshore**: Cable placement and other related construction activities would disturb the seafloor, creating plumes of fine sediment that would disperse and resettle in the vicinity. Burial effects would be short term in duration, effectively ending once the sediments have resettled.	**Offshore**: Jet plow trenching and dredging used to install the IAC, OSS-link cable, and RWEC and construction of the sea-to-shore transition would disturb the seafloor and release plumes of suspended sediment into the water column. However, the sand and mud substrates on the Mid-Atlantic OCS are continually reshaped by bottom	**Offshore**: See Section 3.6.2.7.1 for construction impact analysis. Cable protection maintenance and decommissioning would produce similar effects as those described for the Proposed Action, although reduced in extent. Therefore, resulting adverse effects from O&M and decommissioning would be **minor** adverse. Sediment deposition and burial impacts would result from the estimated up to 105,390 cumulative acres of cabling-related disturbance for Alternatives C through F, plus all other future offshore wind projects within the invertebrate GAA. While suspended sediment effects				**Offshore**: See Section 3.6.2.9.1 for construction impact analysis. Cable protection maintenance and decommissioning would produce similar effects under Alternative G to those described for the Proposed Action, although reduced in extent and varying in

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	Similarly, suspended sediment concentrations close to the disturbance could exceed levels associated with behavioral and physiological effects on invertebrates but would dissipate with distance, generally returning to baseline conditions within a few hours. In theory, bed-disturbing activities occurring nearby (i.e., within a few hundred feet) could elevate suspended sediment levels, resulting in short-term **minor** adverse effects on invertebrates, including some habitat-forming invertebrate species.	currents and sediment delivery from upland sources (Daylander et al. 2012). This means that these habitats and the invertebrates associated with benthic habitat are regularly exposed to and therefore must be able to recover from burial by mobile sediments. In this context, the short-term effects of sediment deposition on benthic habitats would be **negligible** to **minor** adverse. Up to 10% of cable protection could need to be replaced over the life of the Project under the Proposed Action. Cable protection maintenance and decommissioning effects would range from short-term behavioral disturbance of benthic infauna and other invertebrates accustomed to naturally high rates of sediment deposition, to mortality of benthic eggs and invertebrates subject to burial effects greater than 0.4 inch (10 mm). These adverse O&M effects would be **minor** adverse. When combined with other past, present, and reasonably foreseeable actions, the Proposed Action would also result in **minor** adverse cumulative impacts on benthic habitats and invertebrates.	from future projects cannot be predicted without area-specific modeling, these effects are expected to be similar in magnitude and extent to those described for the Proposed Action: **minor** adverse. Cumulative short-term adverse impacts from all planned and future projects are not likely to have measurable population-level effects on any invertebrate species. However, more extensive suspended sediment and deposition effects could occur in areas where mud and silts are more prevalent in bed sediments.				distribution by configuration. Therefore, resulting adverse effects from O&M and decommissioning would be **minor** adverse. Sediment deposition and burial impacts would result from the estimated up to 104,781 cumulative acres of cabling-related disturbance for Alternative G, plus all other future offshore wind projects within the invertebrate GAA. While suspended sediment effects from future projects cannot be predicted without area-specific modeling, the effects produced by Alternative G are expected to be similar in magnitude and extent to those described for the Proposed Action: **minor** adverse. Cumulative short-term adverse impacts from all planned and future projects are not likely to have measurable population-level effects on any invertebrate species. However, more extensive suspended sediment and deposition effects could occur in areas where mud and silts are more prevalent in bed sediments.

3.6.2.2 Alternative A: Impacts of the No Action Alternative on Benthic Habitat

3.6.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for benthic habitat (see Section 3.6.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the benthic GAA. These IPFs are described and analyzed in Appendix E1.

3.6.2.2.2 Cumulative Impacts

This section discloses potential benthic habitat impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

The duration of impacts disclosed for this resource deviate slightly from the general guidelines in Section 3.3 using the following: short term (less than 2 years); long term (2 years to < life of the project); permanent (life of the project).[19] The impact definitions used are the same as described in Section 3.3. The analysis presented below comprises those IPFs associated with planned and future offshore wind energy development that are likely to result in greater than negligible effects on benthic habitat composition and structure. Those IPFs that are likely to result in negligible effects and impacts from other non–offshore wind–related activities are analyzed in Appendix E1, Table E2-3.

Offshore wind development projects will eventually be decommissioned and removed from the marine environment at the end of project life. It is not practicable at this Project to provide specific estimates of the potential extent and magnitude of decommissioning impacts. However, it is anticipated that decommissioning effects on benthic habitat and invertebrates will be broadly similar to those resulting from Project construction, with the exception that unexploded ordnance (UXO) detonation and impact pile driving will not be required. These impacts are described generally herein, with the understanding that BOEM would require every offshore wind project to develop a project-specific decommissioning plan to remove each facility at the end of its operational life. Those plans would all be subject to independent environmental and regulatory review requirements that would fully consider the impacts of project decommissioning in the context of future environmental baseline conditions.

[19] NMFS (2021b) recommends the following temporal definitions: short term (less than 2 years); long term (2 years to < life of the project); permanent (life of the project).

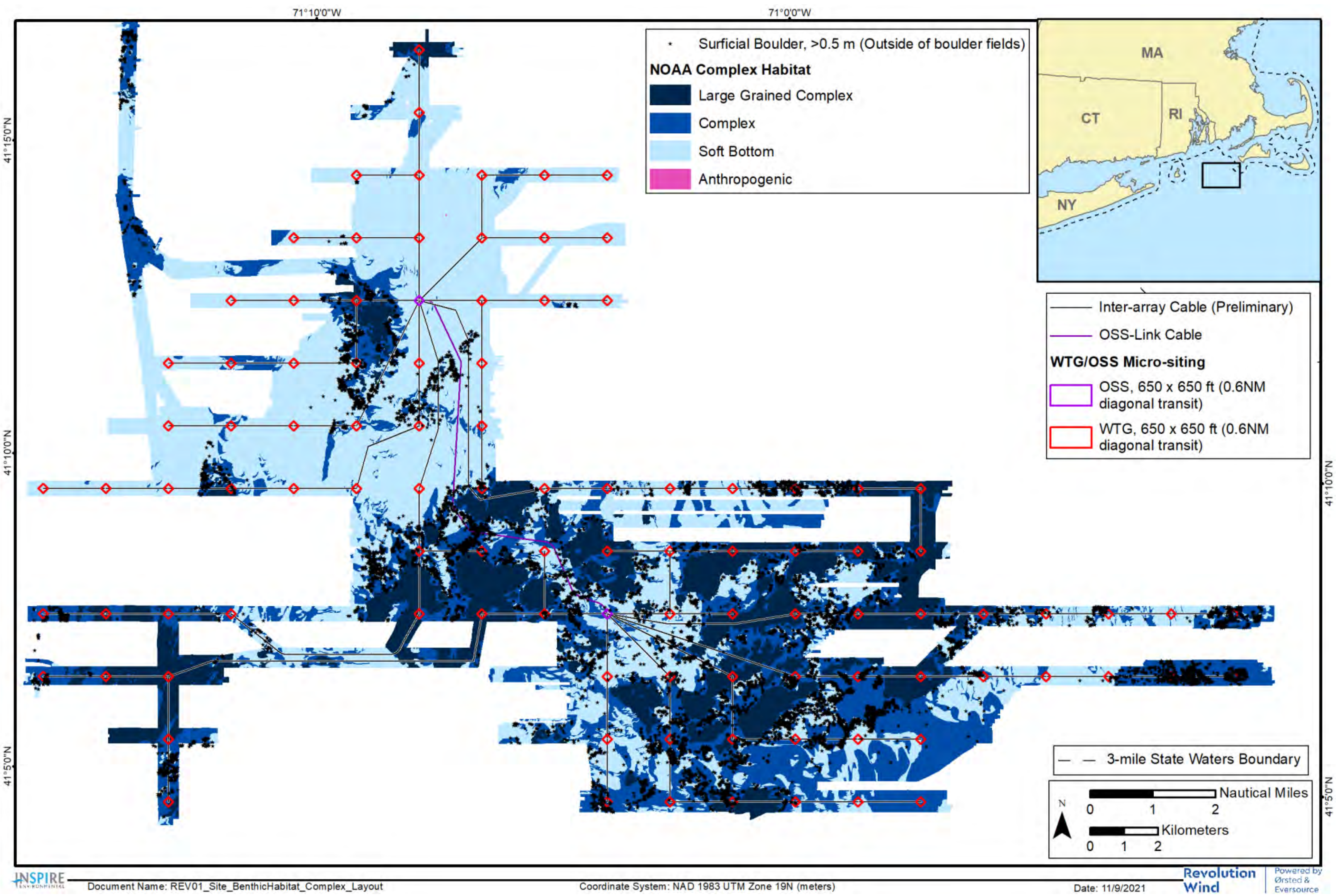


Figure 3.6-2. Distribution of large-grained complex, complex, and soft-bottom benthic habitat within the Revolution Wind Farm maximum work area.

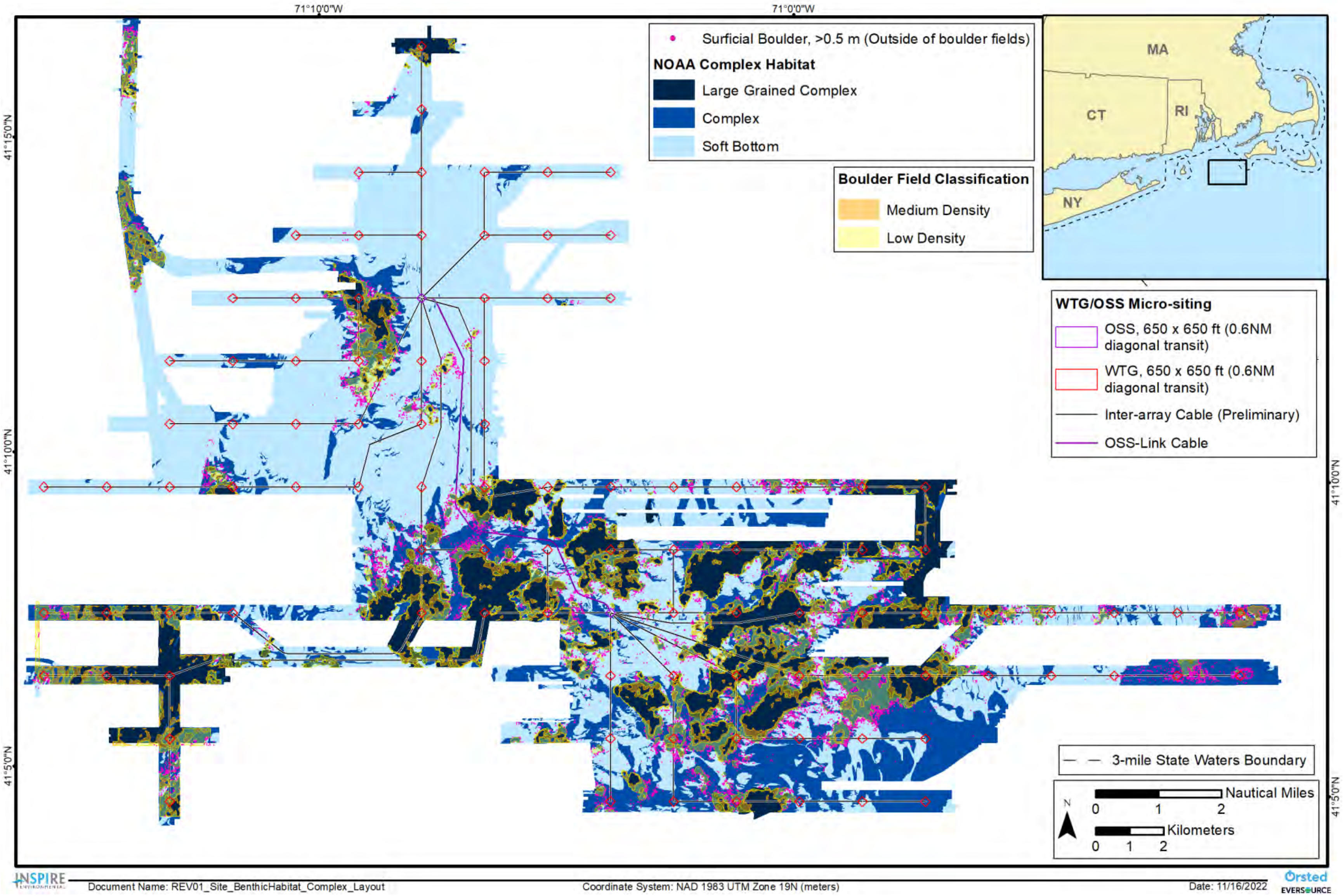


Figure 3.6-3. Distribution of medium-density (246–491 boulders/acre) and low-density (50–245 boulders/acre) boulder fields and scattered surficial boulders (< 50 boulders/acre) within the Revolution Wind Farm maximum work area.

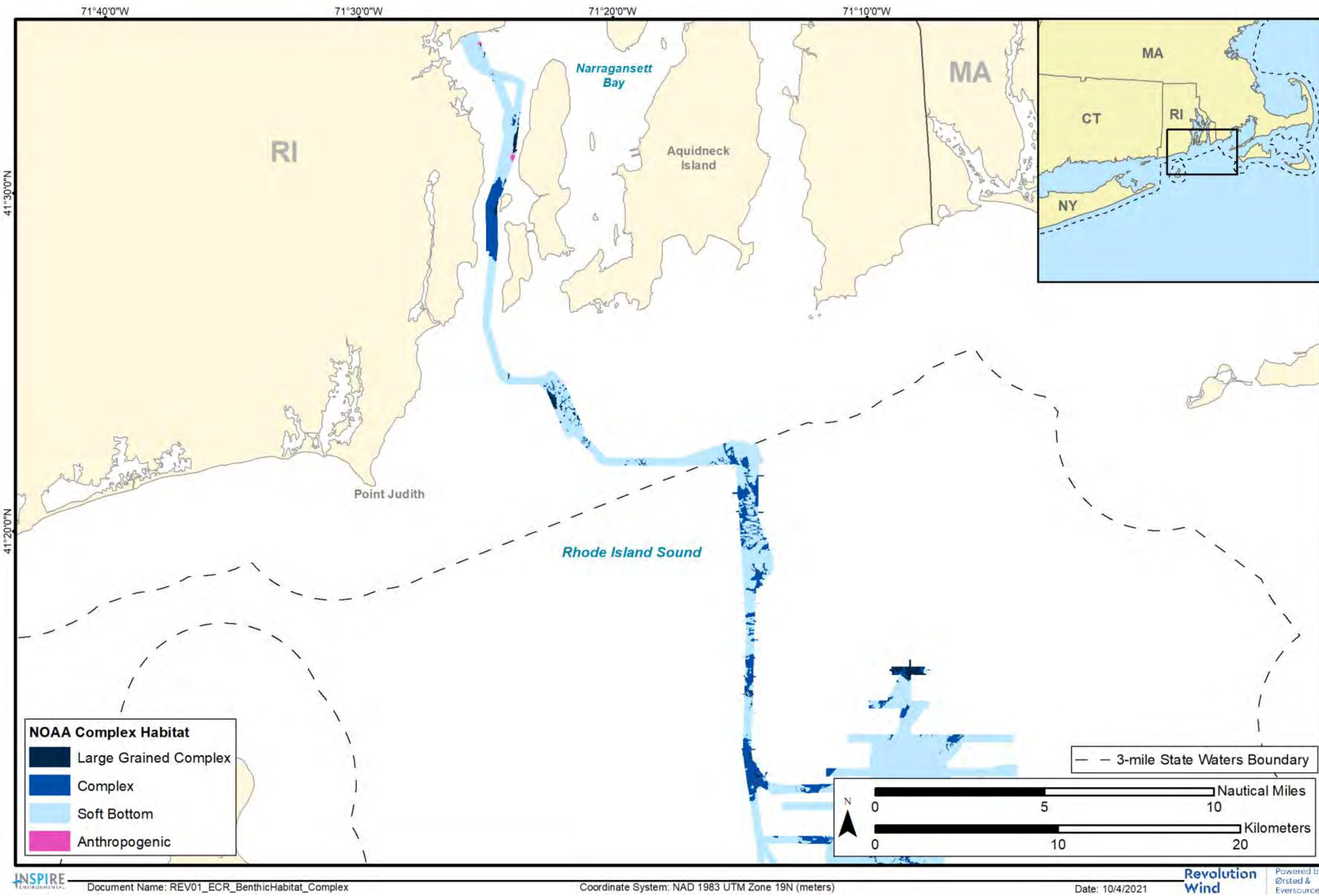


Figure 3.6-4. Distribution of large-grained complex, complex, and soft-bottom benthic habitat within the Revolution Wind Export Cable corridor.

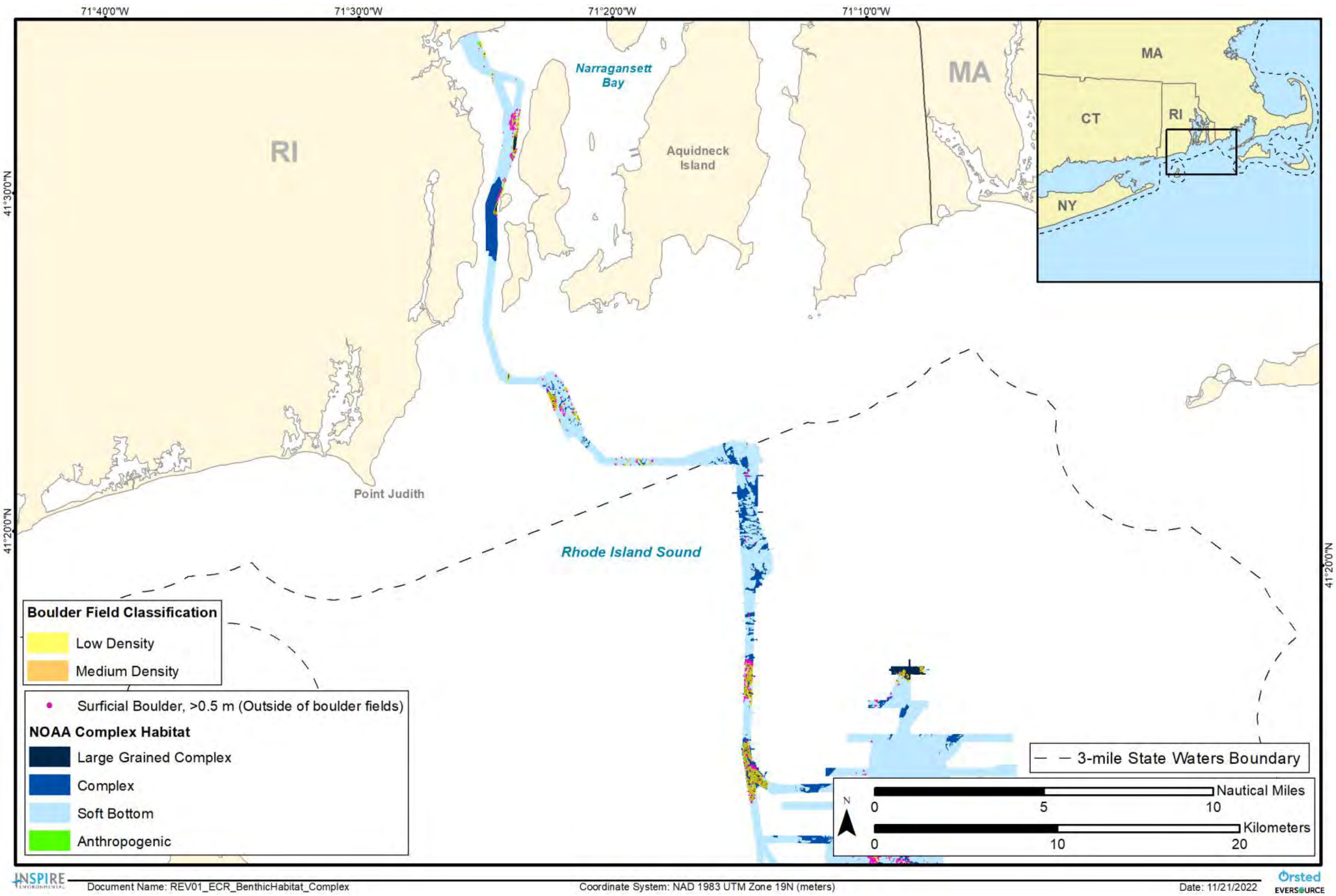


Figure 3.6-5. Distribution of medium-density (246–491 boulders/acre) and low-density (50–245 boulders/acre) boulder fields and scattered surficial boulders (< 50 boulders/acre) within the Revolution Wind Export Cable corridor.

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: Under the No Action Alternative, the Project would not be built. Certain activities such as construction vessel transits and cable emplacement and maintenance activities could conceivably occur within the benthic habitat GAA; however, no specific projects or activities have been identified. In the absence of information about planned non-project activities in the GAA, the impacts of this IPF would be **negligible** adverse. Should future projects include anchoring and cable placement activities within the GAA, **minor** adverse impacts on benthic habitats could result from this IPF. The rationale for this conclusion is based on the same rationale presented for the Proposed Action in Section 3.6.2.4.3.

Climate change: Climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These changes could indirectly affect benthic habitat structure and composition through a variety of mechanisms. For example, changes in freshwater runoff rates and the frequency of large storm events could change the rate of delivery of fine sediments to nearshore environments and sediment transport patterns in the offshore environment. Climate change has resulted in a measurable increase in annual precipitation on the East Coast, increasing the amount of freshwater runoff and the delivery of sediments and stormwater pollutants to coastal and estuarine habitats. This has altered the character of these habitats in ways that have adversely affected some marine species (NOAA 2021). Sediment transport patterns on the Mid-Atlantic OCS are strongly influenced by winter storm events (Daylander et al. 2012). Climate change is projected to lead to a general decrease in wave height and change in wave period on the Mid-Atlantic OCS (Erikson et al. 2016), which could modify these sediment transport patterns. This in turn could alter the structure of certain benthic habitats and the distribution of benthic features like sandwaves and ripples within the GAA over time. Climate change has also influenced benthic habitat composition by altering the environmental conditions experienced by habitat-forming invertebrates in the GAA. For example, warmer water could influence invertebrate migration and could increase the frequency or magnitude of disease (Brothers et al. 2016; Hoegh-Guldberg and Bruno 2010). Ocean acidification, also a function of climate change trends, is contributing to reduced growth or the decline of zooplankton and other invertebrates that have calcareous shells (Pacific Marine Environmental Laboratory [PMEL] 2020). Climate change has also altered the distribution of many fish and invertebrate species, including organisms that prey on and provide forage for habitat-forming invertebrates (see Section 3.6.1.2). These trends are expected to continue under the No Action Alternative. The severity of impacts on benthic habitat resulting from climate change trends are uncertain but are anticipated to range from **minor** to **moderate** adverse and would be effectively permanent.

Presence of structures: Under the No Action Alternative, the Project would not be built and there would be no offshore wind–related structures placed within the GAA and no associated construction and operational activities. No associated effects would occur in the GAA and therefore the impacts of this IPF would be **negligible** adverse.

3.6.2.2.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on benthic habitat and habitat-forming invertebrates associated with the Project would not occur.

Based on the analysis presented under the IPFs above, BOEM anticipates that the planned and future offshore wind activities would have no effect on benthic habitat composition within the GAA for benthic habitat. However, reasonably foreseeable impacts from climate change trends and other ongoing activities like navigation, dredging and dredge disposal, commercial vessel anchoring, and fishing activities would contribute to ongoing adverse impacts on benthic habitat composition. BOEM anticipates that the overall impacts associated with ongoing activities in the GAA combined with reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in **minor** to **moderate** adverse impacts on benthic habitat.

3.6.2.3 Alternative A: Impacts of the No Action Alternative on Invertebrates

3.6.2.3.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for invertebrates (see Section 3.6.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the benthic GAA. These IPFs are described and analyzed in Appendix E1.

3.6.2.3.2 Cumulative Impacts

This section discloses potential invertebrate impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1. The duration of impacts disclosed for this resource deviate slightly from general guidelines provided in Section 3.3 (see footnote in Section 3.6.2.2.2).

Offshore Activities and Facilities

<u>Accidental releases and discharges:</u> Offshore wind energy development could result in the accidental release of water quality contaminants or trash/debris, which could theoretically lead to an increase in debris and pollution in the invertebrate GAA. Additionally, increased vessel traffic associated with offshore wind energy development presents the potential for the inadvertent introduction of invasive species during discharge of ballast and bilge water. This includes invasive invertebrate species that could compete with, prey on, or introduce pathogens that negatively affect native invertebrates. See Section 3.21.1 for an analysis of the contribution of future offshore wind projects to water quality. Compliance with state and federal regulatory water quality requirements would effectively avoid any measurable impacts on invertebrates.

The risk of releases from future offshore wind activities would represent a low percentage of the overall risk from ongoing activities. In the context of reasonably foreseeable environmental trends, the combined impacts on invertebrate resources (mortality, decreased fitness, disease) from accidental releases and discharges are expected to be minimal, localized, and short term due to the likely limited extent and duration of a release. On this basis, the effects of this IPF on invertebrates under the No Action Alternative would be **negligible** adverse.

<u>Anchoring and new cable emplacement/maintenance:</u> Up to 8,427 acres could be affected by anchoring/mooring activities during offshore wind energy development within the invertebrate GAA. As

discussed under benthic habitat, this offshore energy facility construction would involve direct disturbance of the seafloor, leading to direct impacts on invertebrates, and these effects would be localized to the disturbance footprint and vicinity. The severity of these effects would vary depending on the species and life stage sensitivity to specific stressors that extend into the area, resulting in **minor** to **moderate** adverse impacts on invertebrates. Such impacts are expected to be localized and short term but could be long term in duration if they occur in eelgrass beds or permanent if they occur in hard-bottom habitats.

Future projects would also disturb up to 101,381 acres of seafloor from cable installation within the invertebrate GAA. The specific type and extent of habitat conversion and the resulting effects on invertebrates due to seafloor disturbance would vary depending on the project design and site-specific conditions. In addition, bottom-disturbing fishing activities, such as benthic trawl and scallop dredge fisheries, would continue to occur. These activities would result in short-term to long-term alterations of the seafloor. Invertebrates associated with soft-bottom habitat could be displaced if desired habitats, such as biogenic depressions, are altered, and the duration of displacement would vary depending on the nature of the effect. For example, seafloor preparation and cable installation would flatten sand ripples and eliminate or alter depressions in soft-bottom habitats. As stated in Section 3.6.1.1, those habitats are continually reshaped by natural sediment transport processes. Based on observed rates of sediment transport in the region (Daylander et al. 2012), these features would be expected to recover within 18 to 30 months as the seafloor is reshaped by these natural processes. Seafloor-dwelling organisms are adapted to these naturally dynamic conditions and are capable of recovering from disturbance relatively quickly (Grabowski et al. 2014; HDR 2018). In contrast, relocation of boulders into soft-bottom habitat during seafloor preparation could permanently displace invertebrates that rely on sand and mud substrates from the affected footprint. Some of these losses would be offset by the exposure of soft-bottom habitats where boulders were previously located.

Bycatch: A range of monitoring activities have been proposed to evaluate the short-term and long-term effects of existing and planned offshore wind development on biological resources and are also likely for future wind energy projects on the OCS. Some of these monitoring activities are likely to affect invertebrates. For example, the South Fork Wind Fisheries Research and Monitoring Plan (SFWF and Inspire Environmental 2020) included both direct sampling of invertebrates and the potential for bycatch of invertebrates and/or damage to habitat-forming invertebrates by sample collection gear. Biological monitoring uses the same types of methods and equipment employed in commercial fisheries, meaning that impacts to invertebrates would be similar in nature but reduced in extent in comparison to impacts from current and likely future fishing activity. Monitoring activities are commonly conducted by commercial fishers under contract who would otherwise be engaged in fishing activity. As such, research and monitoring activities related to offshore wind would not necessarily result in an increase in bycatch-related impacts on invertebrates, although the distribution of those impacts could change. Therefore, any bycatch-related impacts on invertebrates would be **negligible** to **minor** adverse and short term in duration.

Climate change: As discussed under benthic habitat, climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These changes have affected habitat suitability for the invertebrate community of the GAA. For example, several invertebrate species are shifting in distribution to the northeast, farther from shore and into deeper waters, in response to an overall increase in water temperatures and an increasing frequency of marine heat waves (NOAA 2021). Hale et al. (2017) observed that the biogeographic ranges of several species of subtidal benthic invertebrates, such as clams and bristleworms, are shifting northward in an apparent response to these stressors. Tanaka et al. (2020) project that suitable habitat ranges on the Mid-Atlantic OCS for lobster and sea scallop are likely to shift farther offshore and northward, respectively, in the coming decades. Warmer water could broadly influence invertebrate migration and dispersal, rates of colonization by invasive species, and the frequency and severity of disease outbreaks (Brothers et al. 2016; Hoegh-Guldberg and Bruno 2010). Ocean acidification, also a function of climate change trends, is contributing to the reduced growth or decline of zooplankton and other invertebrates that have calcareous shells (PMEL 2020; Petraitis and Dudgeon 2020). These ongoing changes have altered marine habitats in ways that have adversely affected some marine invertebrate species (NOAA 2021), including habitat-forming organisms. These trends are expected to continue under the No Action Alternative. The intensity of adverse impacts resulting from climate change trends are uncertain but are anticipated to be **minor** to **moderate** adverse.

<u>EMF:</u> Numerous submarine power and communications cables are present within the GAA for invertebrates. These cables would presumably continue to operate and generate EMF effects under the No Action Alternative. Although the type and capacity of those cables are not specified, the associated baseline EMF effects can be inferred from available literature. For example, electrical telecommunications cables are likely to induce a weak EMF on the order of 1 to 6.3 microvolts µV) per meter within 3.3 feet (1 m) of the cable path (Gill et al. 2005). Fiber-optic communications cables with optical repeaters would not produce EMF effects. EMF effects from submarine power cables would be similar in magnitude to those described for the Proposed Action but would vary depending on specific transmission load. For example, the two power cables supplying Nantucket Island at a typical load of 46 kV and 420 amps (Balducci et al. 2019).

Under the No Action Alternative, up to 13,469 miles of offshore wind–related transmission cable would be added in the invertebrate GAA, producing EMF effects in the immediate vicinity of each cable during operations. BOEM anticipates that the proposed offshore energy projects would use high-voltage alternating current (HVAC) transmission, but high-voltage direct current (HVDC) designs are possible and could occur. BOEM would require these future submarine power cables to have appropriate shielding and burial depth to minimize potential EMF effects from cable operation. EMF effects from these future projects on invertebrates would vary in extent and magnitude depending on overall cable length, the proportion of buried versus exposed cable segments, and project-specific transmission design (e.g., HVAC or HVDC, transmission voltage, etc.). The available research on EMF effects on invertebrates is contradictory, varying between studies and by type of transmission, making it difficult to draw definitive conclusions (Hutchison et al. 2020a, 2020b). However, HVAC transmission appears to be less likely to result in measurable physiological or behavioral effects (Hutchison et al. 2020b). Minor effects, should they occur, would be limited to short-term behavioral responses (e.g., brief changes in foraging behavior or swimming direction) that are unlikely to have a biologically significant effect at individual or population levels. Projects that use HVDC transmission could result in greater impacts, but no such projects are currently proposed. HVAC transmission would result in substrate heating effects. In general, these effects are limited to within 2 feet or less of each cable. Cables are typically buried at target depths greater than 4 feet, meaning that invertebrates are unlikely to be impacted by heating effects from buried cable segments. However, substrate heating may occur near the bed surface at the transition points between buried and unburied cable sections, negatively impacting benthic infauna in these specific areas. However, these effects would be limited in extent and would fully recover after the Project is decommissioned and the cables are removed. Accordingly, long-term effects from Project-related EMFs on invertebrates that live in or directly on the seafloor could range from **negligible** to **minor** adverse for projects using HVAC transmission.

Light: Planned future activities include up to 3,088 offshore WTGs and OSS foundations in the GAA for invertebrates. The construction and O&M of these structures would introduce new short-term and long-term sources of artificial light to the offshore environment in the forms of vessel lighting and navigation and safety lighting on offshore WTGs and OSS foundations. Artificial light can attract mobile invertebrates and can influence biological functions (e.g., spawning) that are triggered by changes in daily and seasonal daylight cycles (Davies et al. 2015; McConnell et al. 2010). BOEM has issued guidance for avoiding and minimizing artificial lighting impacts from offshore energy facilities and associated construction vessels (BOEM 2021a; Orr et al. 2013) and has concluded that adherence to these measures should effectively avoid adverse effects on invertebrates, fish, and other aquatic organisms. BOEM would require all future offshore energy projects to comply with this guidance. Given the minimal and localized nature of lighting effects anticipated under this guidance, the related effects from proposed future activities on invertebrates are likely to be **negligible** adverse.

Noise: Numerous proposed offshore wind construction projects could be developed on the Mid-Atlantic OCS between 2022 to 2030 (see Appendix E). This would result in noise-generating activities—specifically, impact pile driving, high-resolution geophysical (HRG) surveys, construction and O&M vessel use, and WTG operation. Based on the scientific research summarized below, BOEM believes it is reasonable to conclude that impact pile driving, construction vessel, and HRG survey noise from future projects could have localized adverse effects on invertebrates. Due to the unknowns associated with proposed projects, the timing and extent of these effects on habitat and aquatic community structure cannot currently be quantified. However, as discussed below, invertebrates are relatively insensitive to underwater noise in comparison to other aquatic organisms like fish and marine mammals. Therefore, the severity of these impacts is likely to be limited to short-term impacts on individuals with no measurable effects at the population level.

Certain construction activities, specifically impact and vibratory pile driving and HRG surveys, would produce intense underwater sound potentially detectable to invertebrates. Invertebrates in general are insensitive to sound pressure and can only detect the particle motion component of sound, or the vibration of the surrounding water column and sediments in immediate proximity to a sound source (Carroll et al. 2016; Edmonds et al. 2016; Hawkins and Popper 2014). Detectable particle motion effects on invertebrates are typically limited to within 7 feet of the source or less (Carroll et al. 2016; Edmonds et al. 2016; Hawkins and Popper 2014; Payne et al. 2007). Intense particle motion exposure can have harmful effects on invertebrate larvae close to (i.e., within inches of) the source (Aguilar de Soto et al. 2013). Vibration from impact pile driving can also be transmitted through sediments. Recent research (Jones et al. 2020, 2021) indicate that longfin squid can sense and respond to vibrations from impact pile driving at a greater distance based on sound exposure experiments. This in turn suggests that infaunal organisms, such as clams, worms, and amphipods, may exhibit a behavioral response to vibration effects over a larger area, but additional research is needed to confirm these effects and their biological significance. Particle motion effects could theoretically cause injury and/or mortality to invertebrates in a limited area around each pile and can cause short-term stress and behavioral changes to individuals over a greater area. The affected areas would likely be recolonized in the short term, and the overall impact on invertebrates would be **minor** adverse.

Tougaard et al. (2020) summarized available monitoring data on wind farm operational noise, including both older generation geared turbine designs and quieter modern direct-drive systems like those proposed for the RWF. They determined that operating turbines produce underwater noise on the order of 110 to 125 root mean square decibels (dB_{RMS}), occasionally reaching as high as 128 dB_{RMS}, in the 10-hertz (Hz) to 8-kilohertz (kHz) range. This is consistent with the noise levels observed at the Block Island Wind Farm (BIWF) (110 to 125 decibels referenced to a pressure of one micropascal [dB re 1 μPa] sound pressure level [SPL] RMS) (Elliot et al. 2019) and the range of values observed at European wind farms. However, the 6-MW direct-drive turbines used at BIWF may not be representative of noise levels produced by higher capacity WTG designs under consideration for planned and foreseeable future wind energy projects. These larger designs have yet to be employed, so no comparable observational data are currently available. Stober and Thomsen (2021) used monitoring data and modeling to estimate operational noise current generation direct-drive WTGs of up to 10 MW in capacity and concluded that these designs could generate higher operational noise levels than those reported in earlier research. This suggests that operational noise effects on invertebrates could be more intense and extensive than those considered herein, but additional research is required to determine if significant effects on invertebrates are likely to occur.

In general, anticipated noise and particle motion levels from Project operations are below levels associated with behavioral and injury-level effects on invertebrates and are comparable to the environmental baseline in busy marine traffic areas. WTG foundations are readily colonized by diverse invertebrate communities (Degraer et al. 2020; Hutchison et al. 2020c), indicating that operational noise has a **negligible** adverse effect on habitat suitability for benthic invertebrate species. Certain invertebrate species, such as cephalopods, may be more sensitive to underwater noise effects (see Section 3.6.2.5.1). Higher capacity WTGs could theoretically produce operational noise approaching levels associated with injury-level effects on cephalopods in recent research (see Section 3.6.2.5.2). However, this is an evolving area of research, and insufficient information is available to determine the likelihood and extent of such effects. Should certain invertebrate species prove sensitive to operational noise effects, effects on invertebrates could range from **negligible** to **minor** adverse, varying by species.

On this basis, underwater noise impacts from future wind energy development would likely result in short-term localized effects on some invertebrate species in immediate proximity to intense sound sources like pile driving. These effects would end when construction is complete. While individual invertebrates could be harmed by noise impacts, potentially harmful impacts would be limited in extent and population-level effects would likely be unmeasurable. Underwater noise from the operation of individual wind farms would last for the life of each project. However, the resulting noise effects are not likely to produce measurable impacts on individual invertebrates. On this basis, noise effects on invertebrates from future wind energy development in the GAA are likely to be **minor** adverse and limited to short-term impacts during project construction.

<u>Presence of structures:</u> The future addition of up to 3,088 new WTG and OSS foundations in the invertebrate GAA would create a network of artificial reef effects that influence invertebrate community structure within and in proximity to the project footprints and beyond. These reefs form biological hotspots that could support species range shifts and expansions, the establishment of nonnative species, and changes in biological community structure. The ecological effects of artificial reefs share some commonality across regions with variation influenced by site-specific oceanographic conditions and the existing biological community (Degraer et al. 2020; Methratta and Dardick 2019; Raoux et al. 2017). The

resulting effects on invertebrates would vary by species. For example, researchers observed changes in invertebrate community composition in sediments surrounding BIWF structures associated with changes in sediment composition caused by nutrient enrichment and the accumulation of shell hash from mussel colonies formed on the structures (Hutchison et al. 2020c). Based on responses observed at BIWF, invertebrates that colonize hard surfaces, like mussels, tunicates, and sponges, are likely to benefit from the new habitats created by offshore wind farms in the invertebrate GAA. Other invertebrate species, such as crabs, worms, and lobsters, that use these complex habitats for cover and foraging would similarly benefit. In contrast, invertebrate species associated with soft-bottom substrates would lose some habitat and could also be affected by changes in nutrient cycling associated with reef effects. Those changes could influence invertebrate community structure in the future, but the nature, extent, and biological significance of these potential changes are difficult to predict and a topic of ongoing research.

Several researchers (e.g., Coolen et al. 2020; Degraer et al. 2020; De Mesel et al. 2015; Hemery and Rose 2020) have raised concerns that offshore wind structures could provide novel habitats for nonnative species, serving as stepping stones that could facilitate the establishment of potentially harmful organisms. Nonnative species have been detected at wind farms in Europe and are commonly species that are already present in intertidal habitats and that are able to exploit newly created wind farm surfaces within a similar depth range near the water surface (Coolen et al. 2020; De Mesel et al. 2015). De Mesel et al. (2015) concluded that nonnative species were able to use wind farm foundations to expand their range within the North Sea. Coolen et al. (2020) similarly observed nonnative species on wind farm structures as well as on oil and gas platforms. Nonnative species were most common at surface to Mid-depths and comparatively rare around the base of the foundations. Hemery and Rose (2020) reviewed the available science and concluded that wind farms do not pose an inherently higher risk of nonnative species invasions than other existing marine installations. Further, these risks can be minimized by managing pathways for nonnative species introductions during project construction and O&M (e.g., through ballast water controls and avoiding ports where high-risk species are known to be present).

Impacts to invertebrates could range from **moderate** beneficial for organisms associated with hard surfaces to **minor** adverse and **minor** beneficial for organisms associated with soft-bottom habitat, varying by species. While reef effects would largely be limited to the areas within and or close to wind farm footprints, the development of individual or contiguous wind energy facilities in nearby areas could produce cumulative effects that could influence invertebrate community structure in the future. The likelihood, nature, and significance of these potential changes are difficult to predict and a topic of ongoing research.

Hydrodynamic disturbance resulting from the development of offshore wind farms is a topic of emerging concern. Human-made structures, especially tall vertical structures such as foundations, alter local water flow at a fine scale by potentially reducing wind-driven mixing of surface waters or increasing vertical mixing as water flows around the structure (Carpenter et al. 2016; Cazenave et al. 2016; Segtnan and Christakos 2015). When water flows around the structure, turbulence is introduced that influences local current speed and direction. Turbulent wakes have been observed and modeled at the kilometer scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). While impacts on current speed and direction decrease rapidly around monopiles, there is a potential for hydrodynamic effects out to a kilometer from a monopile (Li et al. 2014). Direct observations of the influence of a monopile extended to at least 300 m, however, was indistinguishable from natural variability in a subsequent year (Schultze et al. 2020). The range of observed changes in current speed and direction 300 m to 1,000 m from a monopile is likely related to local conditions, wind farm scale, and sensitivity of the analysis. In strongly stratified locations, the mixing seen at monopiles is often masked by processes forcing toward stratification (Schultze et al. 2020), but the introduction of nutrients from depth into the surface mixed layer can lead to a local increase in primary production (Floeter et al. 2017).

A growing body of research has demonstrated that the extraction of energy from the atmosphere and turbulent wakes created by in-water structures could have observable effects on oceanographic conditions up to tens of miles downfield from wind farm sites (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022; Floeter et al. 2022; Raghukumar et al. 2022). These atmospheric and oceanographic effects can also influence stratification and mixing of surface waters, although the extent of these effects and resulting significance on biological processes are likely to vary considerably between different oceanographic environments (van Berkel et al. 2020). Hydrodynamic effects are an issue of concern for offshore wind development on the Mid-Atlantic Bight because of potential effects on an oceanographic feature known as the "cold pool" (Chen et al. 2016). The cold pool is a mass of relatively cool water that forms in the spring and is maintained through the summer by stratification. The cold pool supports a diversity of marine fish and invertebrate species that are usually found farther north but thrive in the cooler waters it provides (Chen 2018; Lentz 2017). Changes in the size and seasonal duration of the cold pool over the past 5 decades are associated with shifts in the fish community composition of the Mid-Atlantic Bight (Chen 2018; Saba and Munroe 2019). Several lease areas within the RI/MA WEA are located on the approximate northern boundary of the cold pool. Changes in cold pool dynamics resulting from future activities, should they occur, could conceivably result in changes in habitat suitability and invertebrate community structure, but the extent and biological significance of these potential effects are unknown.

Van Berkel et al. (2020) and Schultze et al. (2020) note that environments characterized by strong seasonal stratification, such as the Mid-Atlantic Bight, are likely to be less sensitive to changes and disruptions to oceanographic processes from atmospheric effects. In addition, atmospheric effects are influenced by WTG design. Golbazi et al. (2022) demonstrated that the surface effects of wind wakes from 10- to 15-MW WTGs, the size range being considered for development in the region, were less than those produced by smaller turbine designs currently employed in Europe (Akhtar et al. 2022; Christiansen et al. 2022; Daewel et al. n.d. [2023]). Broadly speaking, the atmospheric effects of wind farms appear to decrease as WTG hub height above the sea surface increases. Collectively, these findings indicate that planned and probable future wind farm development on the Mid-Atlantic OCS are not likely to produce hydrodynamic effects on the order of those associated with European wind farm development in the southern North Sea (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022).

This conclusion is supported by regional modeling. BOEM has conducted a modeling study to predict how turbulent wakes and atmospheric effects resulting from offshore wind development in the RI/MA and MA WEAs could affect hydrodynamic conditions in the northern Mid-Atlantic Bight. Johnson et al. (2021) considered a range of development scenarios, including full build-out of both WEAs with 1,063 WTG and OSS foundations at approximately 1 nm spacing. Johnson et al. (2021) determined that all model scenarios would lead to small but measurable changes in current speed, wave height, and sediment transport in the northern Mid-Atlantic Bight. In addition, small changes in stratification could occur. Specifically, stratification within and downfield from the WEAs was likely to strengthen, leading to prolonged retention of cold water near the seafloor during spring and summer. These findings suggest that offshore wind development in these WEAs is unlikely to negatively disrupt cold pool dynamics.

Hydrodynamic effects would lead to changes in surface current and circulation patterns within and around the WEAs, which would in turn affect the dispersal of planktonic organisms, eggs, and larvae. Johnson et al. (2021) used an agent-based model to evaluate how these environmental changes could affect planktonic larval dispersal and settlement for two fish species and the Atlantic sea scallop. In the case of scallops, they determined that offshore wind development could affect larval dispersal patterns, leading to increases in settlement density in some areas and decreases in others. For example, larval dispersal to waters southwest of Block Island is predicted to increase while dispersal to waters south of Martha's Vineyard would decrease under all modeled scenarios (Johnson et al. 2021). These localized effects are unlikely to be biologically significant at population levels, as sea scallop larvae originate in both local and distant spawning areas and are dispersed throughout the region (Johnson et al. 2021).

Prior to the Johnson et al. (2021) analysis, Chen et al. (2016) used a hydrodynamic model to assess how the installation of large numbers of wind turbines on the Mid-Atlantic OCS would impact oceanographic processes during storm events. They determined that structure presence would not have a significant influence on southward larval transport from Georges Bank and Nantucket Shoals to the Mid-Atlantic Bight, but wind farm development could lead to an increase in cross-shelf larval dispersion. The combined findings of the Johnson et al. (2021) and Chen et al. (2016) modeling studies indicate that broad changes in regional circulation patterns are unlikely to occur as a result of regional offshore wind development. These patterns are broadly consistent over time but vary from year to year, and organisms that depend on circulation-driven larval dispersal are adapted to that variability (Chen et al. 2021; McCay et al. 2011; Munroe et al. 2018; Roarty et al. 2020; Zhang et al. 2015). In this context, localized shifts in larval transport and settlement density on the scale of miles to tens of miles are unlikely to negatively affect larval survival at regional scales. Even where they occur, localized changes in larval recruitment may not necessarily translate to negative effects on adult biomass. For example, Atlantic sea scallops are prone to overcrowding and reduced growth rates in areas where larval recruitment exceeds carrying capacity (Bethoney and Stokesbury 2019). In such cases, changes in dispersal that reduce overcrowding could lead to positive effects on larval growth and survival to adulthood.

While hydrodynamic impacts on invertebrates are likely to vary between species, the modeled findings for sea scallops are likely representative of the magnitude of potential effects on any invertebrate species that rely on current-driven dispersal of planktonic larvae. Localized changes in larval settlement patterns in the absence of population-level effects would constitute a **minor** adverse impact on this resource. This impact would be effectively permanent.

<u>Sediment deposition and burial:</u> As previously noted, cable placement and other construction activities would disturb the seafloor, creating plumes of fine sediment that would disperse and resettle in the vicinity. The resulting effects on invertebrates would likely be similar in nature to those observed during construction of the BIWF (Elliot et al. 2017) but would vary in extent and severity depending on the type and extent of disturbance and the nature of the substrates. Invertebrates like burrowing bivalve clams and burrow-forming amphipods are highly tolerant to burial (Gingras et al. 2008; Johnson 2018). More sedentary invertebrates that cannot move within the sediment column as quickly, such as tube-dwelling worms, could exhibit stress or mortality if completely buried (Johnson 2018). Some invertebrate species and their eggs and larvae could be adversely affected by burial by as little as 0.4 inch (10 mm) of fine sediment (Wilber and Clarke 2001), but indicators of stress are typically associated with burial depths on the order of 2 inches or more (Johnson 2018). Burial effects would be short term in duration, effectively ending once the sediments have resettled. Similarly, suspended sediment concentrations close to the

disturbance could exceed levels associated with behavioral and physiological effects on invertebrates but would dissipate with distance, generally returning to baseline conditions within a few hours. In theory, bed-disturbing activities occurring nearby (i.e., within a few hundred feet) could elevate suspended sediment levels, resulting in short-term **minor** adverse effects on invertebrates, including some habitat-forming invertebrate species.

3.6.2.3.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on invertebrate species associated with the Project would not occur. However, ongoing and future activities, specifically the other planned and potential future offshore renewable energy projects identified in Appendix E, would continue to have short- to long-term impacts on invertebrates.

Should the proposed Project not be built, BOEM expects ongoing and future activities, including those related to offshore wind, will continue to affect invertebrates in the GAA. Invertebrates would continue to be exposed to a range of short- to long-term impacts from habitat disturbance, displacement, injury, mortality, and reduced reproductive success resulting from a variety of activities. These primarily include resource exploitation/regulated fishing effort, bottom-disturbing fishing activities, dredging, installation of new offshore structures and transmission cables, the presence of structures, and climate change trends.

Reasonably foreseeable activities other than offshore wind include commercial and recreational fishing effort; increasing vessel traffic; marine surveys, marine minerals extraction, port expansion, and channel-deepening activities; and the installation of new towers, buoys, and piers. Planned and reasonably foreseeable future activities and projects in the invertebrate GAA are summarized in Appendix E. These include planned and potential port expansions and improvements described in Appendix E, Table E-6. These and related activities may have a range of effect on benthic habitats and associated invertebrates (BOEM 2014, 2021b; Grabowski et al. 2014; Michel et al. 2013). BOEM expects the combination of ongoing activities and reasonably foreseeable activities other than offshore wind to result in **minor** to **moderate** adverse impacts on invertebrates, primarily driven by ongoing dredging and fishing activities.

The combined impact-level criteria in Table 3.3-2 and Table 3.3-3 are used to characterize the combined effects of all IPFs likely to occur under the No Action Alternative. BOEM anticipates that the overall impacts associated with future offshore wind activities in the GAA 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 on invertebrate resources. 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. BOEM has concluded that the onshore components of offshore wind energy development are unlikely to measurably affect the marine environment and would therefore have no effect on marine invertebrates.

Likewise, BOEM anticipates that the overall impacts associated with future offshore wind activities in the GAA combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in **moderate** adverse impacts and potentially some **moderate** beneficial impacts for invertebrates. Future offshore wind activities are expected to contribute considerably to several IPFs, the most prominent being the presence of structures. Ongoing and future research surveys and monitoring studies will help improve the understanding of the effects of offshore wind development on invertebrates and other marine species.

3.6.2.4 Alternative B: Impacts of the Proposed Action on Benthic Habitat

3.6.2.4.1 Construction and Installation Offshore Activities and Facilities

Offshore Activities and Facilities

<u>Anchoring and new cable emplacement/maintenance:</u> The construction of the RWF and RWEC would result in a range of short-term and long-term impacts on benthic habitat from vessel anchoring, cable installation, seafloor preparation, and placement of cable protection. The estimated acres of construction-related impacts on benthic habitat resulting from each of these construction activities are summarized in Table 3.6-4.

Table 3.6-4. Acres of Benthic Habitat Disturbance by Construction Activity and Percentage Distribution by Habitat Type

Construction Activity	Maximum Construction Disturbance Footprint (acres)	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
General construction vessel anchoring*	3,167	19.1%	30.1%	50.9%
Jack-up vessel anchoring[†]	21.1	19.0%	29.7%	51.3%
Pull-ahead anchoring[†]	16.1	0.0%	21.4%	78.2%
IAC and cable protection[‡]	1,183	18.6%	26.1%	55.3%
OSS-link cable and cable protection[‡]	59.4	12.5%	26.7%	60.8%
RWEC installation and cable protection[‡,§]	759	2.3%[¶]	22%	75.7%
RWEC cable joint installation	40.8			
Sea to shore transition	0.8	0%	0%	100%
Maximum bed disturbance footprint[¥]	5,247.2	14.9%	27.3%	57.8%

* Estimated total assuming that seafloor impacts from general construction vessel anchoring will occur within a 656-foot radius around each foundation (COP Table 4.1.1-1); acreage shown is the total area for all foundations minus the jack-up vessel anchoring footprint. The values presented represent the acreage and habitat composition of the area where anchoring impacts may occur. The actual footprint of anchoring impacts is not currently known but would likely only represent a fraction of this area.

[†] Jack-up vessel anchoring impacts based on an estimated 0.18 acre of seafloor impacts per vessel jack-up event. OSS foundations will require one jack-up event per installation. An estimated 85% of WTG installations will require one jack-up

event and 15% will require two jack-up events. The total area where general vessel anchoring impacts around foundations may occur assumes a 656-foot (200-m) impact radius. The actual acres of anchoring impacts would likely be less than this total. Pull-ahead anchoring impact estimate calculated using an anchor width of 18 feet, typical drag lengths per set, in sand and medium clay sediments for a 5-metric-ton STEVIN MK3 anchor (Vryhof 2018), and 200, 150, and 50 anchor sets during construction of the RWEC-RI, RWEC-OCS, and OSS-link cable, respectively. Values consider the proportional distribution of mapped sediment types along each cable path.

‡ Values represent the estimated extent of benthic habitat impacts for IAC, OSS-link cable, and RWEC construction. The estimates reflects the maximum footprint of overlapping habitat impacts from seafloor preparation (pre-lay grapnel run, boulder relocation), cable installation, and placement of cable protection. The proportional distribution of impacts by habitat type for each Project element is based on the habitat composition of the approved 40-m wide impact corridor for each Project element. Habitat impacts could occur anywhere within this 40-m wide corridor, which covers approximately 1,355, 1,824, and 122 acres for the RWEC, IAC, and OSS-link, respectively. The total area impacted by placement of cable protection is 74.1 acres for the IAC, 4.4 acres for the OSS-link cable, and 60.6 acres for the RWEC. These impacts would occur within the respective seafloor preparation footprints for each Project component, predominantly in complex benthic habitat where boulders and other hard substrates prevent cable burial. The cable joint installation impact estimate assumes four cable joint installations, two each within RWEC segments on the OCS and in state waters, with a 673-foot-wide impact corridor at each joint location. Acreages shown are non-overlapping impacts extending beyond the seafloor preparation corridor for cable installation.

§ Bed disturbance footprint based on a 23-m-wide average installation corridor width for boulder relocation, the reported proportion of cable route requiring boulder relocation, and an overlapping 7.5-m-wide impact corridor width for cable installation for each RWEC #1 and RWEC #2 cable path with no corridor overlap. These impacts may occur anywhere within a 40-m wide corridor around each cable covering approximately 3,943 acres for all cables combined.

¶ Total includes 0.3% of benthic habitat structure that is anthropogenic in origin (concrete rubble, bridge demolition debris, etc.).

¥ Total acreage represents the estimated total impact footprint, not accounting for jack-up vessel anchoring impacts that overlap the 200-m impact radius for general vessel anchoring. These overlapping impacts may occur later in time.

The estimated anchoring impacts presented in Table 3.6-4 are based on the best currently available information, comprising anchoring information presented in the COP and supplemental information about jack-up vessel anchoring and pull-ahead anchoring provided by Revolution Wind. The general vessel anchoring estimate of 3,167 acres comprises the area covered by one hundred two 656-foot- (200-m-) radius circles, one around each proposed WTG and OSS foundation, where construction-related anchoring impacts may occur. Actual anchoring requirements and the average extent of impacts per foundation would likely be appreciably smaller. Jack-up vessel and pull-ahead anchoring acreage estimates are precise and based on currently understood anchoring requirements and equipment. Jack-up vessel anchoring during WTG and OSS foundation installation would impact approximately 21.1 acres of seafloor habitat. Some portion of these impacts would occur in areas previously impacted by seafloor preparation for foundation installation and subsequently impacted by placement of scour protection. Pull-ahead anchoring for cable installation would impact an estimated 16.1 acres, based on the anticipated number of anchoring events, anchor type, and substrate conditions in the RWEC corridor. Combined impacts from general vessel anchoring, jack-up vessel anchoring, and pull-ahead anchoring would impact up to, but likely less than, an estimated total of 3,204 acres of seafloor. Benthic habitat in the areas wherein anchoring impacts could occur is composed of approximately 19.1% large-grained complex, 30.0% complex, and 50.9% soft-bottom habitats. However, the total acreage and distribution of anchoring impacts cannot be predicted with certainty as anchoring requirements and vessel positioning are affected by construction needs and real-time wind and current conditions. The vessel anchoring plan developed by the applicant (see EPM Ben-6 in Table F-1, Appendix F) will be used to identify and avoid impacts to large-grained complex and complex benthic habitats to the greatest extent practicable. Impacts on bedforms in soft-bottom benthic habitat are expected to recover within 18 to 30 months following initial disturbance as a result of natural sediment transport processes (Daylander et al. 2012) and recolonization by habitat-forming organisms from adjacent habitats. This estimate is based on observed recovery rates from fishing-related disturbance (Grabowski et al. 2014) and from cable installation impacts at the nearby BIWF (HDR 2020) and for similar bed disturbance impacts observed in other regions (de Marignac et al. 2008). In contrast, anchoring in complex and large-grained complex habitats could result in long-term to permanent impacts on habitat structure by redistributing coarse substrates (i.e., creation of anchor furrows) and by damaging habitat-forming organisms on those substrates. These habitats would likely recover to functional condition within 10 years of the disturbance (see Section 3.6.2.5.1). These impacts would constitute a **minor** adverse impact to benthic habitat.

Cable installation impact acreage values presented in Table 3.6-4 represent the best available estimate of the total impact footprint for the Proposed Action design, based on proposed seafloor preparation and cable installation technologies and methods. These impacts could occur anywhere within the 131-foot- (40-m-) wide cable installation impact corridors, which cover an estimated 1,325, 2,471, and 148 acres for the RWEC, IAC, and OSS-link, respectively. The precise location of specific seafloor preparation impacts is not currently known; therefore, the distribution of impacts by habitat type for each cable is based on the composition of its respective impact corridor. Micrositing will be used during construction to minimize impacts on large-grained complex and complex benthic habitats to the greatest extent practicable. This would shift some of the projected impacts on complex habitats to soft-bottom habitat. Therefore, the actual distribution of impacts by habitat type will likely vary from the estimates presented in Table 3.6-4.

Seafloor preparation and cable installation activities would impact approximately 158 and 743 acres of large-grained complex habitat and complex habitat, respectively, and 2,375 acres of soft-bottom habitat within the RWF and RWEC construction footprints. Seafloor preparation in large-grained complex, complex, and heterogenous complex benthic habitats would clear larger substrates like boulders and cobbles from the construction footprint by rolling them to the edge of the clearance area using a large plow dragged behind a construction vessel. Boulder relocation would permanently modify the distribution of substrates in the affected area, resulting in a long-term effect on benthic habitat composition. Moreover, habitat-forming invertebrates damaged or killed during boulder relocation could take several years to fully recover. This would constitute a long-term effect on benthic habitat structure. This seafloor disturbance would constitute a long-term habitat modification resulting in **minor** adverse impacts to benthic habitat (see also O&M effects in Section 3.6.2.2.2).

While placement of concrete mattress cable protection would occur during Project construction, these features would remain in place throughout the operational life of the Project and would have long-term effects on habitat composition in all habitat types. These long-term effects are therefore considered in Section 3.6.2.4.2 under O&M and Decommissioning.

<u>Presence of structures:</u> The installation of up to 102 offshore monopile foundations with associated scour protection would result in the direct disturbance of benthic habitats. The duration of these impacts would vary depending on the type of benthic habitat impacted. Disturbance of soft-bottom benthic habitat would flatten sand ripples, pits, and depressions and kill or displace habitat-forming invertebrates living on and in the seafloor within the impact footprint. Disturbance of complex benthic habitat during seafloor preparation could change benthic habitat composition by relocating boulders and cobbles and exposing soft substrates. The estimated extent of effects by construction activity is summarized in Table 3.6-5. All monopile foundation, cable protection system, and scour protection placement impacts would occur in areas that were previously disturbed during seafloor preparation. Impacts to benthic habitat from the presence of structures would be long term in duration, but the affected habitats would develop into

functional complex habitat over time as they are colonized by habitat-forming invertebrates. Those habitats would recover after structures are decommissioned and removed. Consistent with the impact level definitions presented in Table 3.2-2, the presence of structures would therefore result in a long-term **moderate** adverse effect on benthic habitat.

An unknown proportion of scour protection impacts would occur in areas previously disturbed by general construction and jack-up vessel anchoring during foundation and WTG installation.

Table 3.6-5. Acres of Benthic Habitat Disturbance by Construction Activity and Percentage Distribution by Habitat Type

Construction Activity	Maximum Construction Disturbance Footprint (acres)	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Seafloor preparation*	734	18.9%	29.6%	51.5%
Monopile foundations and scour protection†	74.3	20.0%	30.1%	49.9%
Cable protection systems‡	7.1			

* Revolution Wind estimates that seafloor preparation could be required within approximately 23% of a 656-foot radius, or 7.2 acres, around each WTG and OSS foundation.

† The habitat composition shown is based on the mapped habitat composition within a circular seafloor preparation radius of 316 feet (96 m) and within the proposed monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively. An estimated 0.7 acre of rock scour protection would be placed in a circular area around each monopile. Both monopile and scour protection impacts occur within the seafloor preparation footprint and are overlapping impacts.

‡ Cable protection system installation at WTG and OSS foundation installation would mostly overlap scour protection, but some benthic habitat disturbance would extend beyond the scour protection footprint (approximately 0.07 additional acre per foundation). These impacts will occur within the broader seafloor preparation footprint.

While placement of the monopile foundations, cable protection systems, and scour protection are elements of Project construction and installation, these features would remain in place throughout the operational life of the Project and would have long-term effects on habitat composition in all habitat types. These long-term effects are therefore considered in Section 3.6.2.4.2 under O&M and Decommissioning.

3.6.2.4.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

<u>Anchoring and new cable emplacement/maintenance:</u> Cable protection maintenance and the eventual decommissioning and removal of buried cables would produce similar effects as those described for construction and installation in Section 3.6.2.2.1. These effects would include direct disturbance of the seafloor, suspended sediment deposition in the surrounding area, and injury and displacement of invertebrates using these habitats. Habitat-forming benthic invertebrates could be damaged or killed outright, but the affected hard surfaces would be recolonized over time. Impacts to benthic habitat could include disturbance and relocation of boulders and hard substrates and flattening of ripples and

depressions. These adverse impacts would be short term in duration and would recover over time without mitigation and would therefore be **minor** adverse.

Presence of structures: This section describes long-term alterations of benthic habitat composition, specifically the mixture and distribution of different types of substrates, resulting from the presence of structures under the Proposed Action during operations. This IPF would also result in impacts to benthic habitat structure through effects on habitat-forming organisms, varying in duration by habitat type. Effects to habitat structure resulting from impacts on habitat-forming organisms are discussed under operational impacts on invertebrates in Section 3.6.2.3.2.

The Proposed Action would alter benthic habitat composition, converting existing large-grained complex, complex, and soft-bottom benthic habitat to artificial or introduced hard surfaces. In addition, redistribution of cobbles and boulders during seafloor preparation would convert some existing hard-bottom substrate into soft-bottom substrates and vice versa. For example, anchor scars from BIWF construction created corridors of sandy soft-bottom habitat through existing boulder fields that have persisted since the project was completed (Guarinello and Carey 2020). Similar effects would be anticipated from boulder clearing. The acres of potential impacts to benthic habitat composition and distribution by habitat type are summarized in Table 3.6-6. In general terms, RWF and RWEC installation would permanently displace some benthic habitat within the monopile footprints, would alter the character of existing hard-bottom habitat exposed to reef effects, and would convert some soft-bottom benthic habitat to new hard surfaces in the form of scour protection and concrete mattresses. These effects would be long-term to permanent in duration.

Seafloor preparation for foundation installation would result in the long-term modification of approximately 734 acres of benthic habitat, and the subsequent placement of monopiles, scour protection, and cable protection systems would permanently modify 81.4 acres within this footprint. In total, an estimated 209.5 acres of benthic habitat would be exposed to long-term habitat conversion effects from placement of scour and cable protection within the cable and foundation installation footprints. Of this total, approximately 3.1 acres of habitat would be displaced by monopile foundations. The remainder would be impacted by the placement of scour protection and cable protection systems around each foundation and by placement of cable protection. Approximately 1,835 acres of benthic habitat would be affected by boulder relocation during IAC, OSS-link cable, and RWEC construction, and 128.2 acres within this footprint would subsequently be modified by placement of cable protection. These impacts could occur anywhere within a 131-foot- (40-m-) wide cable installation impact corridor, totaling 3,301 combined acres for the RWEC, IAC, and OSS-link cable.

Table 3.6-6. Acres of Benthic Habitat Disturbance by Operations and Maintenance and Decommissioning Activities and Percentage Distribution by Habitat Type

Operations and Maintenance and Decommissioning Activity	Maximum Seafloor Footprint (acres)	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
WTG and OSS foundations	2.8	20.2%	29.3%	50.5%
Foundation scour protection	71.4	20.0%	30.1%	49.9%
Cable protection systems*	7.1	20.0%	30.1%	49.9%
Cable protection†	128.2	18.5%	26.1%	55.3%
Total	209.5	18.4%	26.6%	55.1%

* Benthic habitat impacts from cable protection systems installed at WTG and OSS foundation installation extending beyond the scour protection footprint (approximately 0.07 additional acre per foundation).

† Protective structures placed on exposed segments of the RWEC, IAC, and OSS-link cable, independent from cable protection systems at monopile foundations. Cable protection requirements are specified in the COP as an estimated percentage of total cable length. These features may be placed anywhere within the 131-foot-(40-m-) wide cable installation corridor totaling 3,301 combined acres for the RWEC, IAC, and OSS-link.

The precise distribution of habitat conversion impacts by benthic habitat type cannot be predicted with certainty as preconstruction micrositing will affect where Project features are ultimately located. However, the habitat conversion impacts described above would occur within areas having the habitat composition shown in Table 3.6-6. In general, long-term impacts from boulder relocation are expected to occur in areas where boulders are most prevalent and are therefore most likely to occur in large-grained complex and complex benthic habitats. However, boulder relocation could move boulders into soft-bottom habitat, changing habitat composition. Cable protection would most likely be required in areas where hard substrates, such as boulder fields, prevent cable burial. This means that cable protection impacts are more likely to occur in large-grained complex and complex habitats, and those acres of impacts would overlap habitats previously impacted by seafloor preparation. However, cable protection would also be used in soft-bottom habitat where required (e.g., at cable crossings). The values presented in this EIS likely overestimate the total acres of impacts that would occur, as micrositing of the foundations and cable routes would emphasize relocating Project features into soft-bottom benthic habitat where practicable. This would reduce the extent of long-term impacts. For example, adjusting cable routes to avoid complex benthic habitat could mean that less cable protection is ultimately required. Therefore, fewer acres of long-term habitat impacts would occur.

The introduction of 102 WTG and OSS foundations would alter pelagic habitats by introducing approximately 1.2 million square feet (107,500 m^2) of vertical hard surfaces into the water column. Over time these foundations, surrounding scour protection, and cable protection mattresses would become colonized by sessile invertebrates, such as mussels, tunicates, anemones, and sponges, creating complex habitat. Damage to complex habitat structure from construction would also recover over time as surfaces are recolonized by habitat-forming organisms, but full recovery could require several years, potentially a decade or more for certain organisms. Long-term effects to benthic habitat structure are described in greater detail under the presence of structures IPF in Section 3.6.2.3.2.

The Proposed Action would permanently alter benthic habitats within the GAA, generating an array of effects on benthic habitat function. Soft-bottom habitats would be permanently displaced while effects on large-grained complex and complex benthic habitats would range from short term to long term or permanent. Some benthic species could recolonize new hard surfaces within 2 to 4 years while others take a decade or more to recover from damage and/or colonize new surfaces like concrete mattresses. For example, concrete mattresses used at the BIWF did not exhibit surface growth of habitat-forming invertebrates after 3 years, but the structures provided refuge space for some fish and invertebrate species (HDR 2020).

This would constitute a long-term reduction in benthic habitat function. In contrast, biologically productive reef effects like those observed at the BIWF would likely develop within 3 to 4 years after construction, continuing to mature over the life of the Project. These effects could be **minor** to **moderate** adverse or **moderate** beneficial, depending on how benthic habitat change influences the broader biological community.

3.6.2.4.3 Cumulative Impacts

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: The Proposed Action would result in localized minor to moderate adverse impacts to benthic habitats and invertebrates through an estimated 3,204 acres of anchoring and mooring-related disturbance and 3,452 acres of cabling-related seafloor disturbance within the benthic habitat GAA. Actual anchoring requirements have not been fully specified, and the former represents an overestimate of probable effects. Further, an appreciable portion of anchoring and cable installation impacts would overlap. Therefore, total acres of benthic habitat impacted by this IPF would likely be smaller than the estimated total of 5,247 acres from these two sources. The duration and magnitude of these effects would vary depending on the types of habitats impacted, ranging from short term to long term or permanent. Short-term impacts on soft-bottom benthic habitats and associated fish and invertebrate species would be expected to fully recover within 18 to 30 months, whereas complex benthic habitats could require several years to recover full habitat function. Recent research obtained by BOEM (2023) suggests that functional recovery of epibenthic organisms would occur within a decade. There would be no cumulative impacts from other planned and reasonably foreseeable offshore wind projects as impacts to benthic habitat from these projects would occur outside the GAA as defined. These totals do not account for other anchoring activities and cable emplacement work that could occur within the GAA over the life of the Project.

Therefore, the Proposed Action when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to benthic habitats and habitat-forming invertebrates.

Climate change: The types of impacts from climate change described for the No Action Alternative would occur under the Proposed Action, but the Proposed Action could also contribute to a long-term net decrease in GHG emissions. This difference may not be measurable but would be expected to help reduce climate change impacts. When combined with other past, present, and reasonably foreseeable actions, climate change trends would result in **moderate** adverse cumulative impacts to benthic habitat and habitat-forming invertebrates under the Proposed Action.

Presence of structures: The Proposed Action would result in the installation of 102 new offshore wind energy structures and associated scour and cable protection in the GAA, resulting in the long-term alteration of benthic habitat composition on approximately 220.5 acres of seafloor. That total would comprise approximately 2.9 and 71.4 acres of seafloor displaced by foundations and associated scour protection, respectively; 7.1 acres of cable protection system impacts extending beyond the scour protection footprint; and 128.2 acres affected by cable protection. The foundations would effectively displace benthic habitat, with each foundation replacing 0.03 to 0.04 acre of seafloor with approximately 1.2 million square feet (107,500 m^2) of vertical surfaces extending from the seafloor to the surface. Impacts to habitat composition from scour and cable protection would vary depending on the type of habitat affected (Causon and Gill 2018; Degraer et al. 2020; Langhamer 2012; Taormina et al. 2018). When placed in soft-bottom habitat, these structures would effectively change the habitat type. When placed in large-grained complex or complex habitat, these structures would either alter the habitat type or modify benthic habitat structure through burial and damage to habitat-forming invertebrates. That habitat structure would recover and would evolve over time into functional benthic habitat as reef effects mature. In all cases, the presence of structures would constitute a long-term to permanent impact to benthic habitat. When reef effects are considered, long-term impacts to benthic habitat composition and structure could be **minor** to **moderate** adverse or **moderate** beneficial, depending on how benthic habitat change influences the broader biological community.

The specific type and extent of habitat conversion and the resulting effects on benthic habitat composition and structure would vary depending on the Project design and site-specific conditions. Once operational, the WTG and OSS foundations and associated scour protection would produce artificial reef effects that influence benthic habitat structure within and in proximity to the Project footprint. While reef effects would largely be limited to the areas within and in proximity to foundation footprints, the development of individual or contiguous wind energy facilities in nearby areas could produce cumulative effects. For example, large quantities of shell hash created by mussels and other colonizing organisms can alter the composition of soft-bottom sediments in the surrounding area. These alterations in substrate composition would be limited in extent to the area of influence around each foundation but would be long term in duration, as changes in substrate composition from the accumulation of shell hash and altered substrate chemistry would continue to persist after the structures are removed during decommissioning. As such, reef effects from the presence of structures would result in cumulative long-term effects on benthic habitat and would range from **moderate** beneficial to **minor** to **moderate** adverse.

3.6.2.4.4 Conclusions

The construction and installation, O&M, and decommissioning of the Proposed Action would impact benthic habitat through several mechanisms, including short-term and long-term habitat disturbance, permanent habitat conversion, and changes in substrate composition and nutrient cycling from reef effects caused by colonization of structures by habitat-forming invertebrates. These effects would alter the structure and function of benthic habitats within the maximum work area, including where cable protection is used, and create new biological hotspots that would benefit some fish and invertebrate species. Long-term to permanent habitat disturbance effects would occur on an estimated 2,570 acres of large-grained complex and complex habitats from vessel anchoring, cable installation and cable protection, seafloor preparation for foundation installation, and the presence of foundations and scour protection. An estimated 131 acres of soft-bottom habitat would be converted to hard bottom habitat by the presence of structures. Collectively, these impacts would constitute a **moderate** adverse effect on benthic habitat, resulting from habitat conversion and long-term impacts to certain types of habitat-forming organisms. These adverse effects would be partially offset by **moderate** beneficial effects on benthic habitat structure and productivity resulting from reef effects. The colonization of artificial structures by a complex community of habitat-forming organisms would increase the structural complexity of benthic habitat in and around WTG and OSS foundations. Some benthic habitat effects could persist even after the Project is decommissioned. For example, reef effects would result in shell hash accumulation around foundations that would remain after the structures are removed. This would alter the composition of sediments within the RWF beyond the life of the Project but would not be expected to negatively affect the ability of benthic habitats to support ecosystem function after the Project is decommissioned.

Collectively, BOEM anticipates that the overall impacts from offshore activities associated with the Proposed Action when combined other with past, present, and reasonably foreseeable activities would result in notable and measurable impacts on benthic habitat. Some of these impacts could persist after the Project is decommissioned, but they would not prevent full recovery of ecosystem function. These findings would constitute a **moderate** adverse impact on benthic habitat composition and **moderate** adverse to **moderate** beneficial effects on benthic habitat structure in the GAA.

3.6.2.5 Alternative B: Impacts of the Proposed Action on Invertebrates

3.6.2.5.1 Construction and Installation

Offshore Activities and Facilities

Accidental releases and discharges: The potential impact to invertebrates from trash and debris from the Project, including habitat-forming invertebrates that contribute to benthic habitat structure, is as described in the No Action Alternative and is **negligible** adverse.

In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, adverse effects on invertebrates, including benthic habitat–forming invertebrates living on or in seafloor sediments, could potentially result. Substrates could also become contaminated with materials that prevent or limit recolonization by these organisms. These effects could be short term to long term in duration, depending on the type and volume of material released and the habitats exposed to spilled material. For example, bunker oil commonly sinks and remains on the seafloor for extended periods before breaking down, whereas diesel fuel and gasoline float on the water surface and weathers more quickly (Etkin 2015). A heavy bunker oil spill could therefore be more damaging to habitat-forming invertebrates on the seafloor. In contrast, spills of diesel fuel or gasoline would remain at or near the water surface, would weather more quickly, and would therefore be less likely to negatively impact benthic habitats. As discussed in Section 3.21.1.2, in the unlikely event that accidental spills should occur, adverse impacts to benthic habitats could range from **minor** to **moderate** adverse in significance depending on the size of the spill and the nature of the materials involved.

Anchoring and new cable emplacement/maintenance: Invertebrates occurring within the impact footprints described in Section 3.6.2.2.1 for cable installation and construction vessel anchoring would be exposed to a range of **minor** short-term to long-term adverse impacts.

Seafloor preparation, cable trenching,[20] vessel anchoring, and short-term bed disturbance at the sea-to-shore transition site would also directly disturb soft-bottom benthic habitat by crushing and displacing epifaunal organisms on the bed surface and liquifying sand and mud sediments from the bed surface to depths of up to 6 feet, killing and displacing benthic infauna within the cable path. These activities would flatten ripples, megaripples, and biogenic depressions that provide habitat for certain invertebrates, including EFH species. Seafloor preparation, cable trenching, and sea-to-shore transition construction would impact up to 1,360 acres of benthic habitat within the installation corridors for the RWF and RWEC (see Table 3.6-4). Approximately 4.8% and 22.7% of these impacts would occur in large-grained complex and complex benthic habitats, respectively, and 72.5% would occur in soft-bottom habitats (see Table 3.6-4).

Invertebrates within these disturbance footprints could be exposed to crushing and burial effects. The extent and severity of exposure will vary by species and life stage–specific sensitivity and habitat association. For example, highly mobile invertebrates like longfin squid or adult crab and lobster would likely be able to avoid being crushed during seafloor preparation and materials placement or overrun by the jet plow. In contrast, immobile or slow-moving benthic invertebrates (e.g., worms, anemones, surf clams, ocean quahogs) and immobile life benthic stages (e.g., longfin squid eggs, post-settlement invertebrate larvae) within the construction footprint would likely be killed by bed disturbance and could also be injured or killed by sediment deposition. Sessile invertebrates, like sponges and hydroids, attached to boulders and cobbles would be damaged or killed when boulders are relocated during seafloor preparation and when scour and cable protection are placed in complex and potentially complex benthic habitats. Mobile benthic invertebrates, like adult lobsters and horseshoe crabs, would likely be able to avoid the jet plow but could be injured or killed by placement of cable protection.

The jet plow injects water into the sediments to liquify the seafloor for cable installation. While the water intake, located near the water surface, is screened to avoid entraining (suctioning) small fish, it would unavoidably entrain and kill zooplankton and planktonic fish eggs and larvae. Zooplankton comprise a diverse group of invertebrate organisms, including larval life stages of crustaceans (crabs and lobsters), echinoderms (urchins and sand dollars), bivalves (clams and mussels), and other species as well as invertebrates that spend their entire lives as zooplankton, such as calanoid copepods. Zooplankton are a central component of the food web and provide an important prey resource for many fish, filter feeding invertebrates, and even large marine mammals like humpback whale (*Megaptera novaeangliae*) and North Atlantic right whale (NARW) (*Eubalaena glacialis*). Inspire Environmental (2019) estimated potential plankton mortality from construction of the 61.8-mile South Fork Export Cable (SFEC) and 21.4-mile SFWF IAC based on jet plow intake volume and movement speed and documented plankton density. It calculated that over a billion fish eggs and 8.5 billion invertebrate zooplankton could be killed by entrainment impacts. Impacts of similar magnitude are likely to result from the construction of the Proposed Action.

While construction impacts could injure or kill invertebrates on over 5,981acres of benthic habitat (see Tables 3.6-4 and 3.6-5) and kill billions of individual phytoplankton, these impacts must be placed into context to evaluate overall impacts. Invertebrates associated with soft-bottom habitat are likely to recover from disturbance within 18 to 30 months (de Marignac et al. 2008; Dernie et al. 2003; Desprez 2000;

[20] The potential equipment used for cable trenching (mechanical cutter, mechanical plow, and jet plow) are expected to have comparable effects to benthic habitat.

Grabowski et al. 2014; HDR 2020). In contrast, epifaunal invertebrates associated with complex benthic habitat, like sponges and hydroids, could take several years to fully recover (Auster and Langton 1999; Collie et al. 2005; Lukens and Selberg 2004; Tamsett et al. 2010). Research obtained by BOEM (2023) suggests that full recovery of habitat function is likely to occur within a decade of disturbance. The study in question compared the community composition and abundance of habitat-forming organisms in heavily fished areas on Georges Bank to reference sites. The findings of this long-term study demonstrated that epifaunal species damaged by repeated exposure to scallop dredging were able to recover to levels that were statistically indistinguishable from unfished reference sites within 6 years. Given the proximity of this study to the Lease Area and the similarity of disturbance, these findings suggest a similar rate of recovery is likely for Project-related construction impacts.

Accordingly, impacts from bed disturbance could range from short term negligible adverse for mobile invertebrates like adult squid and crabs; short term minor adverse for immobile or slow-moving invertebrates like clams, scallops, and worms in soft-bottom habitat; to long-term adverse effects for certain slow-growing invertebrates associated with complex benthic habitat. While the latter effects would be long term in duration, they would be localized and would recover over time without mitigation; therefore, these adverse effects would be **minor** adverse.

Jet plow operation would entrain tens to hundreds of millions of cubic meters of water and billions of organisms, including invertebrate zooplankton. While these values appear significant, they represent a tiny fraction of the total habitat available to zooplankton and typical zooplankton abundance. While zooplankton distribution is not uniform, it is reasonable to conclude that the billions of entrained zooplankton represent a biologically insignificant proportion of the available resource. Moreover, as stated in the previous section, zooplankton have high natural mortality rates, and losses of even several billion organisms may not be measurable relative to year-to-year variation in abundance under natural conditions. On this basis, entrainment effects on invertebrates from cable installation would be short term and likely **negligible** adverse.

The Proposed Action includes EPMs, listed in Table F-1 in Appendix F, which would avoid and minimize impacts on invertebrates. These include design and siting of Project features to minimize the overall Project footprint and impacts on complex benthic habitat where practicable, establishing no-anchor areas to avoid sensitive habitats like observed squid spawning sites. These EPMs would limit, but not completely avoid, crushing, burial, and entrainment impacts on invertebrates. While some impacts would be unavoidable, the affected habitats would recover naturally over time, and impacts on invertebrates are unlikely to be measurable at the population level. Therefore, adverse impacts to invertebrates from this IPF would be **minor** adverse.

Light: Light is an important cue in guiding the settlement of invertebrate larvae (Davies et al. 2015). Artificial light can change the behavior of aquatic invertebrates, although the direction of response can be species and life stage specific. Currently there are no artificial lighting sources present in the RWF or RWEC, except for fishing vessel activity and other periodic vessel transit. The O&M facility would be sited in a currently developed commercial moorage with existing artificial lighting and would not modify existing conditions. Lights would be required on offshore platforms and structures, vessels, and construction equipment during construction of the RWF. Consistent with BOEM guidance (BOEM 2021a; Orr et al. 2013), construction vessels would implement lighting design and operational measures to eliminate or reduce lighting impacts on the aquatic environment. Although individual invertebrates could detect light from construction vessels and could exhibit behavioral responses (e.g., squid being attracted to the lights), these impacts are not expected to measurably affect invertebrates at population levels because of the limited area of impact at any given time and the limited duration of construction activities. Any resulting adverse impacts on invertebrates would be short term in duration and biologically insignificant and therefore **negligible** adverse.

Noise: Construction-related sources of sound pressure and vibration that could affect invertebrates are impact and vibratory pile driving, construction vessels and HRG surveys, and UXO detonation. Invertebrates represent a broad and diverse group of organisms with varying levels of sensitivity to sound disturbance, and sound sensitivity is an evolving field of study (Popper and Hawkins 2018). In general, bivalves and crustaceans are less sensitive to noise-related injury than many fish because they lack internal air spaces and are therefore less vulnerable to sound pressure injuries on internal organs than vertebrates. Available research indicates that many invertebrate species groups, such as cephalopods (e.g., octopus, squid), crustaceans (e.g., crabs, shrimp), and some bivalves (e.g., Atlantic scallop, Atlantic surfclam, ocean quahog) are capable of sensing sound through particle motion (Andre et al. 2011; Carroll et al. 2016; Edmonds et al. 2016; Hawkins and Popper 2014; Popper et al. 2001). Particle motion effects dissipate rapidly and are highly localized around the noise source, with detectable effects on invertebrates typically limited to within 3 to 30 feet of the source (Edmonds et al. 2016; Jézéquel et al. 2022; Payne et al. 2007). However, considerable uncertainty remains about invertebrate sensitivity to various aspects of sound (Popper and Hawkins 2018). Notably, current understanding of fish and invertebrate sensitivity to particle motion effects is limited, and no thresholds have been established to analyze these effects (Popper and Hawkins 2018).

Some species groups may be sensitive to sound-related injury and behavioral effects that do not explicitly involve hearing or particle motion effects. For example, cephalopods, the group of species that includes cuttlefish and squid, may be more sensitive to sound-related injury and behavioral effects than other invertebrate groups. Cephalopods use specialized cells called statocysts for balance and spatial orientation and to detect changes in particle motion that signal the presence of predators and prey. These cells appear to be susceptible to injury from exposure to intense sound pressure (Solé et al. 2018, 2022). For example, Andre et al. (2011) observed damage to statocysts in adult squid exposed to repetitive noise pulses ranging from 157 to 175 dB re 1 μPa over a 2-hour period. Solé et al. (2018, 2022) exposed larvae of various species of cephalopods to underwater noise comparable to impact pile driving and observed similar statocyst injuries. Solé et al. (2022) found that exposure to impact pile-driving noise above 170 dB re 1 μPa^2 caused observable damage to statocysts in cuttlefish larvae and that those effects could be attributed to the sound pressure (versus particle motion) component of noise. That damage resulted in an apparent reduction in survival and reduced response to predator stimuli in the developing larvae. Solé et al. (2018) observed similar statocyst damage in two species of squid exposed to maximum peak noise levels of 175 dB re 1 μPa. Although Kusel et al. (2023) did not explicitly model this threshold value, the acoustic ranges modeled suggest that Project-related impact pile driving could cause injury-level effects on cephalopod larvae at distances on the order of 3,000 to 6,000 feet from each foundation site.

Jones et al. (2020, 2021) determined that longfin squid, an EFH species, can likely sense and exhibit behavioral responses to vibration from impact pile driving transmitted through sediments, potentially several hundred to several thousand feet from the source. They theorized that intense particle motion exposure could have indirect effects (e.g., impaired ability to detect predators or prey) on squid. However, Jones et al. (2020) also observed rapid, short-term habituation of longfin squid exposed to pile-driving sounds. Further, recent studies investigating the potential impacts of pile-driving noise to longfin squid found no statistically significant differences in the ability of squid to capture prey between exposure and control trials (Jones et al. 2021) and short-lived disruptions to fine-scale movements expected to minimally impact energetics (Cones et al. 2022b), and no significant changes in reproductive behaviors, such as mate guarding (Steen 2023) Collectively, these findings suggest that invertebrates like squid could experience injury or behavioral effects from intense underwater noise exposure. However, extensive behavioral impacts are unlikely, as most appear to be short term in duration with exposed individuals exhibiting rapid habituation, limited energetic costs, and no apparent effect on reproductive behaviors. The aforementioned studies were all conducted in laboratory settings that are imperfect representations of the impacts likely to occur in the marine environment. Additional research is needed to establish thresholds for determining the extent and severity of impacts, and field trials should be conducted to test the representativeness of these thresholds in the real world.

Bivalve mollusks also have statocysts, suggesting that this species group could be susceptible to similar impacts. Certain bivalves exhibited behavioral responses to impulsive noise in controlled research. For example, Jézéquel et al. (2022) observed that substrate vibration from impact pile driving caused behavioral responses in Atlantic sea (giant) scallop, specifically rapid closing of shells in response to each pile strike, up to 26 feet (8 m) from the source. No visible responses were observed at 164 feet (50 m) from the source, indicating that these behavioral effects are generally localized to the vicinity of the disturbance. Particle motion effects from pile driving would be short term in duration, lasting for the duration of the noise impact and limited periods (minutes to hours) following exposure. These findings, combined with the research cited above, indicate that invertebrates like clams, worms, and amphipods that live on or in the seafloor could exhibit a behavioral response to vibration effects over a larger area than implied by particle motion effects alone. Although this potential is acknowledged, additional research is needed to confirm these effects and their biological significance.

As of February 2023, 16 UXOs have been identified in the RWEC corridor. Revolution Wind (Orsted 2023) has determined that all 16 devices can be safely avoided by shifting the cable route within the approved installation corridor without the need for detonation. See Figure 2.1-10 in Chapter 2. However, it is possible that additional devices could be discovered prior to or during construction that cannot be avoided or safely relocated. BOEM has concluded that the need for UXO detonation cannot be entirely ruled out; therefore, the potential effects of this activity on invertebrates are considered herein.

Research on invertebrate exposure to UXO detonation is somewhat more limited, but the available research findings for high-intensity impulsive sound sources summarized above would also likely apply. Broadly speaking, measurable effects on benthic invertebrates that are only sensitive to particle motion effects would be limited to habitats within tens of feet of the outer perimeter of the blast zone. In contrast, cephalopods and bivalves could be sensitive to statocyst injury at greater distances. Particle motion effects from UXO detonation could result in mortality of organisms on the munition and within the blast area, injury-level effects, and short-term behavioral responses at greater distances. As stated, UXO detonation is not currently anticipated as part of the Proposed Action. However, should this activity be required, impacts of this magnitude would constitute a **minor** adverse effect on invertebrates.

Revolution Wind estimates that up to 10,779 linear miles of preconstruction HRG surveys will be required. These surveys would be conducted continuously, 24 hours per day, over approximately 248 days of survey effort. Noise generated by construction vessels and HRG survey activities are of much lower intensity (Denes et al. 2021; LGL Ecological Research Associates [LGL] 2022), with behavioral-level effects on invertebrates likely limited to within 7 feet of a continuously mobile noise source. Only pelagic invertebrates like squid would be likely to detect these effects as the HRG equipment is operated well above the seafloor. HRG survey effects are therefore likely to be **negligible** adverse.

Underwater noise from construction activities could also affect invertebrate eggs and larvae. Popper et al. (2014) summarized available research on the sensitivity of finfish to underwater noise effects. They recommended thresholds for lethal injury and temporary threshold shift (TTS) effects by fish hearing group, including fish eggs and larvae, which are summarized in Table 3.6-7. The applicability of the fish egg and larvae threshold to invertebrate eggs and larvae is unclear, but it is used here to estimate the range of potential effects. Noise impacts could be greater if they occur in important spawning habitat, occur during peak spawning periods, and/or result in reduced reproductive success in one or more spawning seasons, which could result in long-term effects to populations if one or more year classes suffer suppressed recruitment. As shown in Table 3.13-1 in Section 3.13.2.2.1 (noise effects on finfish), impact pile driving and UXO detonation are the only noise sources with the potential to affect invertebrate eggs and larvae. Eggs and larvae within approximately 1,680 and 3,458 feet of WTG and OSS monopile installation, respectively, could be injured or killed by cumulative exposure to impact pile-driving noise. As stated, UXO detonation is not currently anticipated, but BOEM conservatively assumes that additional UXOs could be identified within the RWF and/or RWEC corridor during preconstruction surveys that may require detonation in place. The locations where UXOs are most likely to be encountered are within the central portion of the RWF and on the RWEC corridor at the mouth and outside of Narragansett Bay (Ordtek, Inc. [Ordtek] 2021). Should UXO detonation be required, the resulting impacts could kill eggs and larvae from tens to potentially thousands of feet from the source depending on the size of the device. Keevin and Hempen (1997) examined these effects and determined that setbacks of 49, 213, and 656 feet would protect eggs and larvae from detonation effects for 1.1-, 22-, and 220-pound devices, respectively. Extrapolating from this relationship, the setback requirement to protect eggs and larvae from a 1,000-pound UXO, the largest device anticipated in the maximum work area (Hannay and Zykov 2022; LGL 2022), is approximately 1,385 feet (see Table 3.13-2, Section 3.13.2.2.1).

These findings indicate that impact pile driving and, if required, UXO detonation are likely to cause mortality-level effects on some invertebrate eggs and larvae. However, these adverse impacts are likely to be **minor** overall because 1) the areas of effect are small relative to the available habitat, and 2) the loss of individuals would likely be insignificant relative to natural mortality rates for planktonic eggs and larvae, which can range from 1% to 10% per day or higher (White et al. 2014).

Table 3.6-7. Noise Exposure Thresholds for Finfish Lethal Injury, Temporary Threshold Shift, and Behavioral Effects

Sound Source	Fish Hearing Group	Lethal Injury, Peak*,†	Lethal Injury, Cumulative*,‡	Recoverable Injury, Cumulative*,‡	Temporary Threshold Shift*,‡	Behavioral§
Impact pile driving and HRG surveys	Fish with swim bladder, involved in hearing	207	207	203	186	150
	Fish with swim bladder, not involved in hearing	207	210	203	186	150
	Fish without swim bladder	213	219	216	186	150
	Eggs and larvae	210	207	None defined	None defined	N/A
UXO detonation	All fish hearing groups	229	None defined	None defined	None defined	None defined
	Eggs and larvae	>13 mm/s¥	None defined	None defined	None defined	N/A

Note: N/A = not applicable.

* Thresholds from Popper et al. (2014).

† Values in dB re 1 μPa, except where indicated.

‡ Values in decibels referenced to the sum of cumulative pressure in micropascals squared, normalized to 1 second.

¥ Particle acceleration exposure threshold (Popper et al. 2014).

§ Threshold from Fisheries Hydroacoustic Working Group (2008).

Collectively, these findings indicate that sound pressure and particle motion effects could cause injury and behavioral effects to invertebrates at distances ranging from a few feet to several hundred feet, and potentially thousands of feet, from each pile. These effects would vary considerably by species group. Behavioral effects are also likely to occur over similar distances, again varying by species group. These effects would be short term in duration, and the overall impact on invertebrates would be **minor** adverse.

Presence of structures: Invertebrates within the benthic disturbance footprints for foundation installation, described in Section 3.6.2.2.1, could be exposed to crushing and burial effects. Some individual invertebrates would unavoidably be injured or killed, but the number of individuals affected would be insignificant relative to the size of the population and the resource would recover completely without additional mitigation. The time required for recovery would vary depending on the type of habitats affected, ranging from short term for invertebrates found in soft-bottom habitats to long term for invertebrates associated with large-grained complex and complex habitats. Therefore, adverse effects to invertebrates from construction of structures would be **minor** adverse.

Sediment deposition and burial: The Project conducted a model-based analysis of the anticipated extent and magnitude of suspended sediment impacts on water quality and benthic habitats in COP Appendix J (RPS 2022). This analysis considered impacts from jet plow trenching for IAC and OSS-link cable installation, jet-plow and mechanical trenching used to install the RWEC, and dredging associated with sea-to-shore transition construction. It determined that suspended sediments released into the water column would be rapidly dispersed by tidal currents, settling back to the seafloor within minutes to hours of the disturbance. Most water column effects would be limited to short-term TSS pulses below 100 mg/L. Higher TSS concentrations exceeding 100 mg/L would occur in areas where seafloor sediments have a greater proportion of mud and silt. TSS plumes caused by construction disturbance would dissipate quickly, with concentrations above 100 mg/L lasting no longer than 6 hours at any location (RPS 2022). A summary of the anticipated extent of water column TSS and substrate burial effects is provided in Table 3.6-8.

Suspended sediments will resettle on the seafloor, blanketing the existing habitat with layers of fine sediment of varying thickness. Sediment deposition from IAC construction could exceed 0.4 inch (10 mm) and 0.004 inch (0.1 mm) on up to 273 and 10,081 acres, respectively. Burial depths from OSS-link cable construction could exceed 0.4 inch (10 mm) and 0.004 inch (0.1 mm) on up to 8.6 and 918 acres, respectively. Burial depths from RWEC construction could exceed 0.4 inch (10 mm) and 0.004 inch (0.1 mm) over 35 and 8,354 acres, respectively. Burial effects on invertebrates would be short term in duration, lasting for minutes to hours after initial bed disturbance as suspended sediments resettle on the seafloor. The actual area of effect at a given moment during construction would be limited to the seafloor disturbance footprint within and adjacent to cable installation activities and the deposition zone downcurrent of the disturbance. IAC and OSS-link cable installation impacts would occur intermittently over a 5-month construction window while the RWEC installation would occur continuously over a period of approximately 8 months. Impacts from other activities like anchoring and boulder relocation were not modeled but are likely to be similar in magnitude but reduced in extent per unit mile of activity relative to jet plow trenching. These impacts would occur prior to cable installation, meaning that this IPF would produce sequential impacts on some benthic habitats.

The magnitude and duration of construction-related sediment effects must be considered in the context of the environmental baseline. As stated in Section 3.6.1.2.1, the sand and mud substrates on the Mid-Atlantic OCS are continually reshaped by bottom currents and sediment delivery from upland sources (Daylander et al. 2012). The prevalence of sediment ripples and megaripples throughout the maximum work area is evidence of these dynamic conditions. This indicates that the benthic habitats associated with invertebrates affected by the Project are regularly exposed to and therefore must be able to recover from burial by mobile sediments. In this context, the short-term effects of sediment deposition on benthic habitats would be **negligible** to **minor** adverse.

Table 3.6-8. Estimated Maximum Extent of Total Suspended Solid Plumes and Area of Sediment Deposition Resulting from Inter-Array Cable, Offshore Substation-Link Cable, and Revolution Wind Export Cable Construction

Project Element	Location	Length (miles)	0.004 inch (acres)	0.04 inch (acres)	0.4 inch (acres)	50 mg/L (feet)	100 mg/L (feet)
IAC*	OCS	155.3	20,096	10,081	273	1,209	932
OSS-link cable‡	OCS	9.3	1,444	918	9	1,209	932

Project Element	Location	Length (miles)	0.004 inch (acres)	0.04 inch (acres)	0.4 inch (acres)	50 mg/L (feet)	100 mg/L (feet)
RWEC #1 and #2, installation‡	OCS	37.3	5,786	3,684	35	1,542	1,476
	State	46.0	8,031	4,670	0	3,764	2,345
Sea-to-shore transition†	State	N/A	35	20	7	1,460	1,312

* RPS (2022) did not estimate deposition acreage for the entire IAC. Sediment deposition and burial effects for IAC installation were estimated for this EIS based on the modeled deposition acreage per mile for IAC, OSS-link cable, and RWEC segments for different substrate classifications reported by Inspire Environmental (2023), and the proportional distribution of IAC segments by substrate classification. Values are averages of modeled results for two different tidal current regimes.

‡ RPS (2022) modeled TSS impact estimates for RWEC #1 and the OSS-link cable combined. OSS-link cable values are estimated using the modeled deposition rate/mile for comparable substrate classes in the RWEC footprint. RWEC deposition area results are two times the RPS (2022) results for RWEC #1 minus the estimated OSS-link cable deposition area, assuming that RWEC #2 impacts will be similar to those from RWEC #1 based on proximity and routing through similar benthic habitat types.

† The RPS (2022) model scenario assumed excavation and backfill of a combined 5,881 cubic yards of sediment at the HDD exit pit using a backhoe excavator and venturi eductor device.

3.6.2.5.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Accidental releases and discharges: The prohibitions on releases of trash and debris and accidental spill avoidance and minimization measures described in Section 3.6.2.3.1 for project construction would continue to apply throughout the operational life of the Project. These restrictions and measures would effectively avoid adverse effects from Project-related trash and debris and accidental spills. Therefore, the effects of this impact mechanism on invertebrates would be **negligible** adverse.

Anchoring and new cable emplacement/maintenance: Cable protection maintenance would produce similar effects on habitat-forming invertebrates as those described for Project construction. The IAC, OSS-link cable, and RWEC would be removed from the seafloor during Project decommissioning. Removal of cable protection and extraction of the cable from the seafloor would disturb sediments, releasing TSSs into the water column. The resulting effects from O&M and decommissioning would be short term in duration, and similar in nature but lesser in magnitude than those resulting from Project construction. Therefore, these effects would be **minor** adverse.

Bycatch: The RWF FRMP employs a variety of survey methods to evaluate the effect of RWF construction and operations on benthic habitat structure and composition and economically valuable fish and invertebrate species. The survey methods in Table 3.6-9 either directly assess or could impact invertebrates.

Table 3.6-9. Survey Methods

Survey Method	Description
Ventless trap surveys	Used to evaluate changes in the distribution and abundance of lobster and Jonah crab in the RWF and adjacent reference areas and Jonah crab, lobster, whelk (Buccinidae), and finfish along the RWEC corridor and adjacent reference areas; these areas would be surveyed 12 times per month for 7 months each for 2 years prior to and at least 2 years following completion of Project construction (4 years total).
Otter trawl surveys	Used to assess abundance and distribution of target fish and invertebrate species within the RWF; trawls could impact a variety of invertebrate species as bycatch; these surveys would occur four times per year for 2 years prior to and at least 2 years following completion of Project construction.
Benthic habitat surveys	Sonar, video, and photographic imaging are used to evaluate changes in benthic habitat structure and invertebrate community composition.

These surveys involve similar methods to and would complement other survey efforts conducted by various state, federal, and university entities supporting regional fisheries research and management.

The trawl and ventless trap surveys would target specific invertebrate species, squid and crabs and lobster, respectively, using methods and equipment commonly employed in regional commercial fisheries. Organisms captured during surveys would be removed from the environment for scientific sampling and commercial use. Other species of invertebrates could also be impacted by sampling activities. For example, benthic invertebrates could be injured or killed when survey equipment contacts the seafloor or when inadvertently captured as bycatch. Non-target organisms would be returned to the environment where practicable, but some of these organisms would not survive. While the FRMP would result in unavoidable impacts to individual invertebrates, the extent of habitat disturbance and number of organisms affected would be small in comparison to the baseline level of impacts from commercial fisheries and would not measurably impact the viability of any species at the population level. Randomized sampling distribution means that repeated disturbance of the same habitat is unlikely. As such, habitat impacts from FRMP implementation would likely be short term in duration. The intensity and duration of impacts anticipated from FRMP implementation would constitute a **minor** adverse effect on invertebrates.

<u>EMF:</u> The IAC, OSS-link cable, and RWEC would generate EMF and substrate heating effects, altering the environment for benthic invertebrates and other organisms associated with those habitats. These effects would occur throughout the operational life of the Project and cease with Project decommissioning.

The Proposed Action includes EPMs to minimize EMF impacts. The Project would employ HVAC transmission at 60 hertz (Hz). HVAC transmission produces lower intensity EMFs than HVDC and, as discussed further below, the 60-Hz electrical fields generated by HVAC transmission would be undetectable or unlikely to be detected by electrosensitive organisms. All transmission cables would be contained in grounded metallic shielding to minimize electrical field effects and buried to target depths of 4 to 6 feet (1.2 to 1.8 m) or deeper in soft-bottom benthic habitat and other areas where burial is possible. Cable segments that cross unavoidable hard substrates and other offshore infrastructure would be laid on the bed surface covered with a concrete mattress or other form of cable armoring for protection. EMF effects in these areas would be greater than for buried cable segments. EMF levels diminish rapidly with distance and would become indistinguishable from baseline conditions within about 26 feet (8 m) of both buried and exposed cable segments (Exponent 2023). Modeled EMF effects for buried and exposed cable segments under annual average and peak transmission loads are summarized in Table 3.6-10.

Hughes et al. (2015) and Emeana et al. (2016) evaluated the thermal effects of buried and exposed electrical transmission cables on the surrounding environment. They determined that heat from exposed cable segments would dissipate rapidly without measurably heating the underlying sediments. In contrast, the typical HVAC cable buried in sand and mixed sand and mud (i.e., soft-bottom benthic habitat) can heat sediments within 1.3 to 2 feet (0.4 to 0.6 m) of the cable surface by +10 to 20 degrees Celsius (°C). Substrate heating effects are also summarized in Table 3.6-10. Substrate heating effects are strongly influenced by site-specific characteristics, like the size and mixture of substrate sediments and sediment porosity. For this reason, this estimate likely represents the upper bound of potential heating effects in soft-bottom habitat. Heating effects in coarser-grained sediments with higher porosity would likely be less extensive.

Table 3.6-10. Modeled Electromagnetic Field Levels and Estimated Substrate Heating Effects Under Average and Peak Load Conditions for Buried and Exposed Cable Segments and Miles of Cable by Category for the Proposed Action

Component	Installation	Total Cable Length (linear miles)	Magnetic Field (mG) at Seafloor	Magnetic Field (mG) 3.3 Feet above Seafloor	Electrical Field (mV/m at 60 Hz) at Seafloor	Electrical Field (mV/m at 60 Hz) 3.3 Feet above Seafloor	Substrate Heating
IAC*	Buried to 3.3 feet	139.8	57–82	17–24	2.1–3.0	1.3–1.8	+10 to +20°C within 0.4 to 0.6 m of cable
	On bed surface	15.5	522–745	35–50	5.4–7.7	1.7–2.5	Negligible
OSS-link cable†	Buried to 3.3 feet	8.4	147–210	41–58	4.4–6.3	2.3–3.2	+10 to +20°C within 0.4 to 0.6 m of cable
	On bed surface	0.9	1,071–1,529	91–130	13–18	3.5–4.9	Negligible
RWEC†	Buried to 3.3 feet	70.6	147–210	41–58	4.4–6.3	2.3–3.2	+10 to +20°C within 0.4 to 0.6 m of cable
	On bed surface	12.7	1,071–1,529	91–130	13–18	3.5–4.9	Negligible

Note: mG = milligauss; mV/m = millivolt/meter.

* Value ranges shown are modeled effects under average and peak load conditions, estimated as 66 kV at 480 and 685 amps, respectively, for the IAC cable (Exponent 2023).

† Value ranges shown are modeled effects under average and peak load conditions, estimated as 275 kV at 690 and 985 amps, respectively, for the RWEC and OSS-link cables (Exponent 2023).

The evidence for EMF effects on invertebrates is equivocal, varying considerably between species and by the type and strength of EMF source (Albert et al. 2020; Gill et al. 2020; Hutchison et al. 2020b). Several studies have observed no apparent behavioral responses in crustaceans and mollusks at EMF field strengths similar to the highest levels likely to result from IAC, OSS-link cable, and RWEC segments laid on the bed surface (e.g., Love et al. 2017). Some studies (e.g., Cameron et al. 1985; Levin and Ernst 1995; Ottaviani et al. 2002; Stankevičiūtė et al. 2019; Zimmerman et al. 1990) have observed apparent physiological effects on organisms like clams, mussels, urchins, and worms with exposure to EMF from HVAC transmission at levels similar to those shown in Table 3.6-10, whereas other studies have observed no apparent effects on similar organisms from much higher exposures over longer periods (Gill et al. 2020; Hutchison et al. 2020b). These contradictions are compounded by differences in study methods and the type of EMF exposure (i.e., HVDC versus HVAC transmission), making it difficult to draw conclusions about invertebrate sensitivity to EMF effects (Hutchison et al. 2020b). On balance, there is limited evidence to suggest that exposure to Project-related HVAC EMF fields could lead to measurable effects on benthic infauna. Any measurable effects that do occur would be localized to the areas of greatest exposure in immediate proximity to the cables. Developmental effects leading to reduced survival of individual animals could conceivably occur, but the numbers of individuals affected would not be significant at the population level. Given this uncertainty, the potential permanent effects from Project-related EMFs on invertebrates that live in or directly on the seafloor are conservatively assumed to range from **negligible** to **minor** adverse. Any measurable EMF effects, should they occur, would be limited to individuals occurring within the immediate zone of measurable EMF effects.

While directed studies are limited, there is little evidence that epibenthic and pelagic invertebrates like crabs and squid are sensitive to EMFs from HVAC transmission of comparable or greater intensity than those likely to result from the Proposed Action (Love et al. 2015; Normandeau et al. 2011; Williamson 1995). The preponderance of evidence suggests that EMFs from the Project would have **negligible** adverse effects on invertebrates like longfin and shortfin squid, both EFH species.

Transmission cables would also generate substrate heating effects with the potential to negatively impact invertebrates, although these effects would be limited in extent and likely not biologically significant. Heating effects would likely be greatest in predominantly silt and mud sediments with little or no substrate porosity. In this type of environment, cable heating effects could increase substrate temperatures by as much as 10°C to 20°C above ambient within 1.3 to 2 feet (0.4 to 0.6 m) of buried cable segments (see Table 3.6-10). This estimate may be conservatively high in coarser sediments with higher porosity. Temperature changes of this magnitude, should they occur, could adversely affect Atlantic surfclam and ocean quahog (Acquafredda et al. 2019; Harding et al. 2008) as well as other benthic infauna species. However, the amount of suitable habitat exposed to these effects would be limited. Cable burial at 4 to 6 feet (1.2 to 1.8 m) would limit substrate heating effects to depths 2 feet or more below the bed surface, below the depths inhabited by most invertebrate species. Cable segments at the transitions between fully buried and exposed cable segments would be at shallower depths, potentially exposing quahog and surfclam habitat and other invertebrate infauna species habitat to adverse thermal effects. However, these shallow cable segments are likely to be covered by concrete mattresses, meaning that the affected areas would no longer be available to these species. The latter impacts are accounted for under presence of structures. On this basis, substrate heating impacts, while permanent, would have a **negligible** adverse effect on invertebrates.

Light: As discussed in Section 3.6.1.2.1, all planned and future offshore wind energy projects would follow BOEM design guidance (BOEM 2021a) for offshore energy structures and vessels. Compliance with this guidance would effectively minimize long-term light impacts from O&M of the Proposed Action such that effects on invertebrates, including habitat-forming invertebrates that contribute to benthic habitat structure, would be **negligible** adverse. The proposed WTG and OSS structural lighting for the Project, shown in Section 2.1.2.2.1, fully complies with BOEM guidance. Vessels used during decommissioning would follow the same or improved guidance to avoid and minimize lighting impacts as those used for project construction (see Section 3.6.2.3.1). Therefore, short-term light effects on invertebrates from decommissioning of the Proposed Action would similarly be **negligible** adverse.

Noise: The RWF WTGs would generate permanent operational noise effects throughout the life of the Project, ending when the Project is decommissioned. The Project would employ current generation direct-drive WTG designs that generally produce less underwater noise and vibration than older generation WTGs with gearboxes. Much of our current understanding about operational noise is based on the monitoring of wind farms in Europe that use these older generation designs. Although useful for generally characterizing potential noise effects, these data are necessarily representative of the noise produced by current generation designs (Elliot et al. 2019; Tougaard et al. 2020). Typical noise levels produced by older generation geared WTGs range from 110 to 130 dB re 1 μPa with 1/3-octave bands in the 12.5- to 500-Hz range, sometimes louder under extreme operating conditions (Betke et al. 2004; Jansen and de Jong 2016; Madsen et al. 2006; Marmo et al. 2013; Nedwell and Howell 2004; Tougaard et al. 2009, 2020).

Monitoring of operational noise produced by the BIWF (Elliot et al. 2019) supports the conclusion that modern WTG designs generally produce less noise than older generation models. The BIWF employs five 6-MW direct-drive WTGs. Operational noise from these WTGs was generally lower than noise levels generated by older, lower capacity WTGs at European wind farms as reported in the literature (Betke et al. 2004; Jansen and de Jong 2016; Madsen et al. 2006; Marmo et al. 2013; Nedwell and Howell 2004; Tougaard et al. 2009, 2020). Operational noise levels typically ranged from 110 to 125 re 1 μPa, occasionally reaching as high as 128 dB re 1 μPa, mostly at low frequencies ranging from 10 Hz to 8 kHz. Particle acceleration effects on the order of 10 to 30 dB re 1 $\mu m/s^2$ at a reference distance of 50 meters. Although the BIWF provides a useful basis for evaluating noise levels produced by direct-drive systems, no comparable observational data have been collected for the larger capacity WTGs proposed for the Project. Stober and Thomsen (2021) modeled operational noise from larger current generation direct-drive WTGs and concluded that these designs could generate considerably higher operational noise levels than those reported in earlier research. They estimated that a 10-MW direct-drive design could produce noise levels on the order of 167 dB re 1 μPa. This suggests that operational noise effects could be more intense and extensive than those considered herein, but additional research is needed to confirm these theoretical findings.

Invertebrates lack specialized hearing organs and cannot sense sound pressure in the same way as fish and other vertebrates. Invertebrates can sense sound as particle motion, but particle motion effects dissipate rapidly and are usually undetectable within a few feet of the source. Broadly speaking, the rapid development of diverse invertebrate communities on foundations and scour protection in operational wind farms worldwide (see the presence of structures IPF below) indicates that operational noise has little if any effect on benthic invertebrates. Certain species, specifically squid, may be more sensitive to sound than other species, such as crustaceans and bivalves. The sound pressure and particle motion effects observed at the BIWF are well below levels associated with injury and behavioral responses in cephalopods and other invertebrate species groups. However, the larger WTG designs proposed for the Project could theoretically produce operational noise approaching levels associated with injury-level effects on cephalopods in recent research (e.g., Solé et al. 2018, 2022). However, the likelihood of such effects and the area affected would depend on the specific noise levels produced by the selected WTG in this environment, and recent studies (BOEM 2023) have indicated the impacts of underwater noise on longfin squid, a managed species present in the Lease Area, are minimal (see Section 3.6.2.5.1). Collectively, this information indicates that operational noise effects on invertebrates would be **negligible** to **minor** adverse.

Project vessels used during O&M, decommissioning, and O&M-related HRG survey activities would generate similar noise effects to those described for Project construction in Section 3.6.2.3.1 and would likewise be **negligible** adverse.

Presence of structures: The new hard structures created by RWF foundations, scour protection around the foundations, and cable protection would displace existing habitat for invertebrates that use soft-bottom benthic habitat and create new habitats for invertebrates that colonize hard surfaces. As stated previously, approximately 1.5 acres of soft-bottom benthic habitat would be displaced by monopile foundations, 34.1 acres would be displaced by scour protection around the foundations, and 81.2 acres would be displaced by concrete mattresses protecting exposed segments of the IAC, OSS-link cable, and RWEC. Those habitats would no longer be available to invertebrate infauna like tube worms, copepods, and bivalves, including three EFH species (Atlantic surfclam, Atlantic sea scallop, and ocean quahog). Longfin squid, another invertebrate EFH species, also associate with soft-bottom benthic habitat.

Habitat for invertebrates that colonize hard surfaces or associate with complex benthic habitat would increase. Epibenthic organisms (e.g., mussels and anemones) and crustaceans that prefer hard-bottom habitat (e.g., American lobster and crab) would gain habitat. The available evidence indicates that recovery of benthic habitat structure would begin quickly and would likely be relatively rapid, but full recovery of the community of habitat-forming organisms could take up to a decade. For example, Degraer et al. (2020) have documented the development of diverse invertebrate communities on offshore wind structures around the globe. Hutchison et al. (2020a) documented the development of a diverse and biologically productive invertebrate community that developed on turbine foundations at the nearby BIWF within 3 years after construction. The structures were initially colonized by dense aggregations of mussels and barnacles, followed by corals, hydroids, anemones, and predatory invertebrates like crabs, sea stars, and snails. A nonnative tunicate, already widespread and common in the region, is also present. Shell hash and detritus falling from the foundations changed the composition of and enriched the surrounding sediments, increasing biological productivity. These effects extended beyond the scour protection footprint surrounding each foundation. Based on the proximity of RWF structures to the BIWF, it is reasonable to conclude that RWF structures would develop a similarly diverse biological community over a similarly short period.

Similar artificial reef effects have been observed at other offshore wind facilities (Causon and Gill 2018; Degraer et al. 2020; Langhamer 2012; Taormina et al. 2018). While these findings indicate relatively rapid recovery of benthic community structure in general, some impacts may be longer lasting. Certain types of habitat-forming invertebrates, such as sponges and corals, are sensitive to disturbance and slow growing. These more sensitive species can take decades to fully recover and recolonize damaged habitats (Tamsett et al. 2010), but functional habitat recovery can likely be achieved in a decade or less based on observational studies within and outside the region (Auster and Langton 1999; BOEM 2023; Collie et al. 2005; Lukens and Selberg 2004).

Offshore wind structures could in theory provide a foothold for harmful nonnative species invasions. Several researchers (e.g., Coolen et al. 2020; Degraer et al. 2020; De Mesel et al. 2015; Hemery and Rose 2020) have raised concerns that offshore wind structures could provide novel habitats for nonnative species, serving as stepping stones that could facilitate the establishment of potentially harmful organisms. Nonnative species have been observed at the BIWF (Hutchison et al. 2020c), but negative impacts on native biological communities have yet to be demonstrated. Nonnative species have been detected at wind farms in Europe and are commonly species that are already present in intertidal habitats and that are able to exploit newly created wind farm surfaces within a similar depth range near the water surface (Coolen et al. 2020; De Mesel et al. 2015). De Mesel et al. (2015) concluded that nonnative species were able to use wind farm foundations to expand their range within the North Sea. Coolen et al. (2020) similarly observed nonnative species on wind farm structures as well as on oil and gas platforms. Nonnative species were most common at surface to mid-depths and comparatively rare around the base of the foundations. Hemery and Rose (2020) reviewed the available science and concluded that wind farms do not pose an inherently higher risk of nonnative species invasions than other existing marine installations. Further, these risks can be minimized by managing pathways for nonnative species introductions during Project construction and O&M (e.g., through ballast water controls and avoiding ports where high-risk species are known to be present).

In general, reef effects are likely increase the diversity and biological productivity of the invertebrate community within and around the RWF over time (Causon and Gill 2018). The resulting effects on invertebrates would vary by species and could be positive, negative, or neutral depending on a variety of factors. For example, the displacement of soft-bottom benthic habitat would constitute a limited but permanent **moderate** adverse impact on invertebrates that use this habitat type. Some of these negative effects could be offset by organic enrichment and increased biological productivity in soft-bottom habitats at the edge of the reef effect zone (e.g., Hutchison et al. 2020c). Invertebrate species that associate with hard substrates and vertical relief created in the water column would gain new opportunities for habitat colonization that would otherwise not be present in the offshore environment, resulting in **minor** to **moderate** beneficial effects, with the level of benefit varying depending on the structures involved. For example, foundations and scour protection at the BIWF were rapidly colonized by epifaunal invertebrates, creating a diverse community of habitat-forming organisms within 4 years (Hutchison et al. 2020c). In contrast, concrete mattresses used for cable protection at the BIWF showed no measurable invertebrate community growth at 3 years following installation (HDR 2020), indicating that this type of structure will take longer to develop functional habitat value.

Hydrodynamic effects resulting from the presence of offshore wind structures could also affect the distribution and abundance of invertebrates within and around the RWF. Current movement around wind farm foundation also generates turbulent wakes that promote increased mixing downcurrent of the structures. Turbulent wakes can range from several hundred feet to potentially a mile or more in scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). While impacts on current speed and direction decrease rapidly around monopiles, modeling studies suggest a potential for hydrodynamic effects out to 0.6 mile downcurrent (Li et al. 2014). Monopile wakes of up to 1,000 feet have been observed in real-world environments, but the resulting turbulence effects were indistinguishable from natural interannual variability (Schultze et al. 2020). The broad range of observed and predicted wake effects are likely influenced by local conditions, wind farm scale, and sensitivity of the analysis. In strongly stratified locations, the turbulent wake effects are often masked or muted by the oceanographic processes that create stratification (Schultze et al. 2020). Even in strongly stratified environments, turbulent mixing that introduces nutrients from depth into the stratified surface layer can lead to a local increase in primary production (Floeter et al. 2017).

A growing body of research has demonstrated that offshore wind farms could have observable effects on oceanographic conditions up to tens of miles downfield from wind farm sites (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022; Floeter et al. 2022; Raghukumar et al. 2022). These field effects can also affect stratification and mixing of surface waters, which can in turn influence important ecological processes like larval dispersal and primary productivity. However, the extent and resulting ecological significance of these effects are likely to vary considerably between different oceanographic environments (van Berkel et al. 2020). Van Berkel et al. (2020) and Schultze et al. (2020) note that environments characterized by strong seasonal stratification, such as the Mid-Atlantic Bight, are less sensitive to changes and disruptions to oceanographic processes from atmospheric effects. In addition, atmospheric effects are influenced by WTG design. Golbazi et al. (2022) demonstrated that the surface effects of wind wakes from 10- to 15-MW WTGs, the size range being considered for development in the region, were appreciably less extensive than those produced by the smaller turbine designs currently employed in Europe (Akhtar et al. 2022; Christiansen et al. 2022; Daewel et al. 2022). Broadly speaking, the atmospheric effects of wind farms appear to decrease as WTG hub height above the sea surface increases.

Collectively, these findings indicate that planned and probable future wind farm development on the Mid-Atlantic OCS are unlikely to produce hydrodynamic effects on the order of those associated with European wind farm development in the southern North Sea (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022). As discussed in Section 3.6.2.3.1, this conclusion is supported by the findings of the Johnson et al. (2021) hydrodynamic modeling study conducted for BOEM. This study determined that the planned introduction of offshore wind energy structures to the RI/MA and MA WEAs would likely lead to small but measurable changes in current speed, wave height, and sediment transport in the northern Mid-Atlantic Bight. However, changes are unlikely to disrupt the prevailing strong seasonal stratification present on the Mid-Atlantic OCS.

Windfarm effects on surface currents are also likely to influence the dispersal of planktonic invertebrate and fish larvae within the WEAs and their surroundings, increasing larval settlement in some areas and decreasing it in others (Johnson et al. 2021). Changing larval dispersal pathways can disrupt connectivity between populations and the processes of larval settlement and recruitment (Sinclair 1988). Large-scale hydrodynamic changes can create population ‘sinks,’ subpopulations that are reproductively isolated from other regional populations by unfavorable changes in larval dispersal (Sinclair 1988). While some hydrodynamic effects on larval dispersal patterns are likely to occur as a result of the Proposed Action, and these impacts would last until the Project is decommissioned, the available evidence suggests that full development of the RWF would be unlikely to cause this type of adverse population-level effect on any invertebrate species.

The rationale for this conclusion is based on the nature of the regional oceanographic environment and its invertebrate populations. The invertebrate species of the Mid-Atlantic OCS use numerous broadly distributed spawning locations from which larvae are transported by regional circulation patterns over distances ranging from tens to hundreds of miles (Chen et al. 2021; McCay et al. 2011; Munroe et al. 2018; Roarty et al. 2020; Zhang et al. 2015). The Johnson et al. (2021) modeling results indicate that Project-related shifts in larval transport and settlement density would be localized, with changes in settlement density occurring at the scale of miles to tens of miles within the natural variability of these broader regional patterns. Prior to the Johnson et al. (2021) analysis, Chen et al. (2016) used a hydrodynamic model to assess how the installation of large numbers of wind turbines on the Mid-Atlantic OCS would impact oceanographic processes during large storm events. They determined that structure presence would not have a significant influence on southward larval transport from Georges Bank and Nantucket Shoals to the Mid-Atlantic Bight, but wind farm development could lead to an increase in cross-shelf larval dispersion. The combined findings of the Johnson et al. (2021) and Chen et al. (2016) modeling studies indicate that broad changes in regional circulation patterns are unlikely to result from regional offshore wind development. These patterns are broadly consistent over time but vary from year to year, and organisms that depend on circulation-driven larval dispersal are adapted to that variability (Chen et al. 2021; McCay et al. 2011; Munroe et al. 2018; Roarty et al. 2020; Zhang et al. 2015). In this context, localized shifts in larval transport and settlement density on the scale of miles to tens of miles are unlikely to negatively affect larval survival at regional scales. Even where they occur, localized changes in larval recruitment may not necessarily translate to negative effects on adult biomass. For example, Atlantic sea scallops are prone to overcrowding and reduced growth rates in areas where larval recruitment exceeds carrying capacity (Bethoney and Stokesbury 2019). In such cases, changes in dispersal that reduce overcrowding could lead to localized beneficial effects on larval survival and growth to adulthood.

On this basis, BOEM concludes that the Proposed Action is likely to result in measurable hydrodynamic effects on invertebrates. Those effects would include changes in egg and larval dispersal patterns and the resulting effects on survival and growth to adulthood. Those effects could be positive or negative for individual organisms but are unlikely to lead to measurable consequences at population levels. The hydrodynamic effects of the Proposed Action would cease when the Project is decommissioned and removed. On this basis, hydrodynamic impacts of the Proposed Action would constitute a **minor** adverse effect on invertebrates. These impacts would cease when the Project is decommissioned, and subpopulation distribution would shift in response to the oceanographic conditions present at that time, as determined by climate change trends and other regional trends.

To summarize, long-term habitat modification caused by the presence of structures would create winners and losers, with some invertebrate species losing suitable habitat while others would gain. Negative population-level effects are unlikely to occur, as invertebrate species that lose habitat would still have abundant habitat available and those in proximity to new structures could benefit from increased biological productivity created by reef effects. On balance, the effects of this IPF on invertebrates are likely to be long term **moderate** beneficial and **moderate** adverse in terms of overall impact, varying by species and habitat association. Concrete mattresses used for cable protection may have to reside in the environment for some time before they provide suitable invertebrate habitat, which would constitute a long-term **minor** adverse impact depending on the amount of cable protection used.

O&M under the Proposed Action would include regular inspections of offshore structures and opportunistic removal of derelict fishing gear and other accumulated debris over the life of the Project. Derelict gear and debris are sources of bycatch mortality for invertebrates and can also cause damage to habitat-forming organisms that contribute to benthic habitat structure. Derelict gear and debris removal from structures would constitute a long-term **minor** beneficial effect on invertebrates and habitat-forming organisms that contribute to benthic habitat structure.

Sediment deposition and burial: Up to 10% of cable protection is anticipated to be replaced over the life of the Project. Cable protection maintenance would produce similar effects on habitat-forming invertebrates as those described for Project construction, although reduced in extent and spread out over time. These effects would range from short-term behavioral disturbance of benthic infauna and other invertebrates accustomed to naturally high rates of sediment deposition, to mortality of benthic eggs and invertebrates subject to burial effects greater than 0.4 inch (10 mm). The IAC, OSS-link cable, RWEC, and cable protection would be removed from the seafloor during Project decommissioning, releasing TSSs into the water column. The resulting adverse effects from O&M and decommissioning would be similar in nature but lesser in magnitude than those resulting from Project construction and would therefore be **minor** adverse.

3.6.2.5.3 Cumulative Impacts

Offshore Activities and Facilities

Accidental releases and discharges: Based on compliance with environmental regulations, the Proposed Action when combined with past, present, and reasonably foreseeable projects would result in **negligible** adverse cumulative effects on invertebrates from accidental releases and discharges.

When the Project is combined with other future offshore wind projects, up to approximately 34 million gallons of coolants, fuels, oils, and lubricants could cumulatively be stored within WTGs and the OSSs' within the invertebrate GAA. All vessels associated with the Proposed Action and other offshore wind projects would comply with USCG requirements for the prevention and control of oil and fuel spills. Additionally, training and awareness of EPMs (see Table G-1 in Appendix G) proposed for waste management and marine debris would be required of RWF Project personnel. These releases, if any, would occur infrequently at discrete locations and vary widely in space and time, and impacts would be minimized through planned EPMs and other mitigation measures detailed in Tables F-1 and F-2, respectively, in Appendix F. Impacts to invertebrates, including habitat-forming species, from small-volume spills are therefore expected to be **negligible** adverse and short term in duration.

Higher volume spills of toxic materials could occur due to unanticipated events, such as a vessel allision with a WTG foundation. The nature and significance of such events would vary depending on the size of the release and the nature of the materials involved. Such events could lead to more extensive impacts on invertebrates, including habitat-forming species that contribute to benthic habitat structure. When low-probability unanticipated events are considered, the Proposed Action when combined with other past, present, and reasonably foreseeable projects poses a potential for **minor** to **moderate** adverse cumulative impacts on invertebrates that could range from short term to long term in duration.

Anchoring and new cable emplacement/maintenance: BOEM estimates a cumulative total of 11,631 acres of anchoring and mooring-related disturbance and 105,390 acres of cabling-related disturbance for the Proposed Action plus all other future offshore wind projects within the invertebrate GAA. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Impacts on soft-bottom benthic habitats and associated fish and invertebrate species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take a up to a decade to fully recover.

Therefore, the Proposed Action when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to invertebrates and on benthic habitat structure through impacts to habitat-forming invertebrates.

Bycatch: As discussed under O&M, the Proposed Action includes implementation of a FRMP to evaluate the effects of Project construction and structure presence on economically valuable fish and shellfish resources (Revolution Wind and Inspire Environmental 2023). Other planned and potential future offshore wind energy projects have or will likely implement similar monitoring plans that employ similar sampling methods using commercial fishing gear. These monitoring programs have and will likely continue to contract with commercial fishers to conduct data collection. The commercial fishers involved would likely otherwise be engaged in commercial fishing activity, meaning that planned and future monitoring activities are unlikely to increase the amount of fishing effort and associated impacts on invertebrates in the GAA relative to existing conditions. However, the distribution and timing of those impacts may change. As such, cumulative impacts from bycatch associated with monitoring activities under the Proposed Action in combination with other planned and future offshore wind projects would be **negligible** to **minor** adverse, with the impacts ranging from short term to long term in duration. Long-term impacts could result from damage to habitat-forming invertebrates in large-grained complex and complex benthic habitat and would also constitute an impact to benthic habitat structure.

The Proposed Action would include regular inspections to identify and remove derelict fishing gear and other trash and debris attached to offshore structures. Other future projects are expected to include similar measures in their O&M plans. This O&M effort would benefit invertebrates by removing potential sources of bycatch and benthic habitat structure by removing a source of potential damage to habitat-forming invertebrates. This O&M effort would continue over the life of the Project and other future wind energy projects and would therefore constitute a long-term **minor** beneficial effect on invertebrates and benthic habitat structure.

Climate change: In addition to the impacts described in the No Action Alternative (see Section 3.6.1.2), climate change has also resulted in a measurable increase in precipitation on the East Coast, increasing the amount of runoff and stormwater pollutants delivered by rivers to coastal and estuarine habitats. These trends are expected to continue under the Proposed Action. The intensity of climate change cumulative impacts on invertebrates are uncertain and are likely to vary considerably between species, resulting in **moderate** adverse effects.

EMF: Under the Proposed Action the Project would generate EMF and substrate heating effects of varying intensity along the combined 252 miles of IAC, OSS-link cable, and RWEC length. These effects would combine with those generated by the 13,717 miles of transmission cables from other future offshore wind facilities and existing transmission cables present within the invertebrate GAA. These cumulative effects would be similar in nature to those described for the No Action Alternative in Section 3.6.1.1.1. In summary, measurable effects on invertebrates from EMF exposure would be limited to individuals that occur in the immediate proximity (i.e., within 20 feet) of Project cables and range from short-term changes in behavior with no significant long-term consequences to potential physiological changes with prolonged exposure. Substrate heating effects could render small amounts of habitat unsuitable for certain benthic invertebrate species at locations where buried cables are within 2 feet of the bed surface. Effects to individuals are unlikely to have a measurable impact on any invertebrate species at the population level and would therefore range from negligible to minor adverse depending on the type of exposure. BOEM anticipates that future offshore wind energy projects in the GAA would use HVAC (versus HVDC) transmission and apply similar design measures to those included in the Proposed Action avoid and minimize EMF effects on the environment. While uncertainties remain, cumulative adverse impacts to invertebrates from EMF and substrate heating effects resulting from past, planned, and potential future actions are likely to be **minor** adverse.

Light: The Proposed Action would result in noticeable but negligible adverse impacts to invertebrates through the installation of up to 102 lighted structures (100 WTGs and two OSSs). The Proposed Action and all future projects would be expected to comply with BOEM design guidance for avoiding and minimizing adverse lighting impacts on the environment (BOEM 2021a), meaning that effects to invertebrates would be negligible and adverse. Therefore, the cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable future activities would be similar to those impacts described under the No Action Alternative and would be **negligible** adverse, mostly attributable to existing, ongoing activities.

Noise: The Proposed Action would generate underwater noise effects during Project construction, throughout the operational life of the Project, and during Project decommissioning. These effects would combine with similar effects resulting from the construction, O&M, and decommissioning of other planned offshore wind projects on the Mid-Atlantic OCS. Sound-sensitive invertebrate species occurring near UXO detonation and impact pile-driving and vibratory pile-driving activities could suffer noise-related injury to sensory cells, resulting in reduced survival. The number of individuals affected is unlikely to have any measurable effect on those species at the population level. Less sensitive species may be temporarily disturbed by vibration effects, but any such effects would be short term in duration and are unlikely to have a measurable effect on any invertebrate population. Given this, cumulative effects on invertebrates resulting from underwater noise caused by the Proposed Action are likely to be **negligible** to **minor** adverse, varying by species.

Presence of structures: The Proposed Action would result in long-term alteration of water column and seafloor habitats, resulting in a diversity of effects on benthic habitat and invertebrates, including EFH species. The 102 monopile foundations and other hard surfaces installed as part of the Proposed Action would create an artificial reef effect. The new offshore structures would also cause hydrodynamic effects that would influence primary and secondary productivity within and around the artificial reef and effects on planktonic invertebrates, eggs, and larvae. Reef effects would alter biological community structure, producing an array of effects on invertebrates, and would create an artificial reef effect. The new offshore structures would also cause hydrodynamic effects that would influence primary and secondary productivity within and around the artificial reef, influencing the dispersal and survival of planktonic invertebrates and eggs and larvae. Reef effects would alter biological community structure, producing an array of effects on invertebrates. The affected invertebrates and habitats would interact with construction and O&M impacts caused by other planned offshore wind projects within the GAA. These projects would individually result in similar effects to those described for the Proposed Action, but the potential for synergistic cumulative effects at regional scales is not presently known. Those cumulative effects could be beneficial or adverse, varying by species, and would likely range from **minor** adverse and beneficial to **moderate** adverse and beneficial in terms of overall impact.

The Proposed Action is comparable in scale compared to some of the offshore renewable energy projects planned in the GAA. BOEM estimates the Proposed Action and other planned future projects will result in the development of 3,190 WTG and OSS foundations within the invertebrate GAA. Many of these projects will or could be developed in adjacent lease areas. Depending on how they are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential impacts of these broader cumulative effects on invertebrates in general.

Sediment deposition and burial: The Proposed Action would result in localized short-term **minor** adverse sediment deposition and burial effects on benthic habitat and invertebrates. Short-term burial effects exceeding 10 mm would occur over an estimated 3,412 acres within the invertebrate GAA. Similar sediment deposition and burial impacts would result from the estimated 105,390 cumulative acres of cabling-related disturbance for the Proposed Action plus other future offshore wind projects within the invertebrate GAA. While suspended sediment effects from future projects cannot be predicted without area-specific modeling, these effects are expected to be similar in magnitude and extent to those described for the Proposed Action. More extensive suspended sediment and deposition effects could occur in areas where mud and silts are more prevalent in bed sediments. Some future projects could include dredging for O&M facility development or related port improvements. When combined with other past, present, and reasonably foreseeable actions, the Proposed Action would result in **minor** adverse cumulative impacts on benthic habitats and invertebrates.

The development of the Proposed Action in combination with other future offshore wind projects would generate similar sediment deposition and burial effects to those described above under project construction and installation (Section 3.6.2.3.1), but those effects would be more extensive and distributed across offshore WEAs within the GAA. As stated, these effects would be short term in duration and would range in severity from negligible to minor adverse at any given location. Cumulative short-term impacts from all planned and future projects are not likely to have measurable population-level effects on any invertebrate species; therefore, cumulative adverse effects from sediment deposition and burial would be **minor** adverse.

3.6.2.5.4 Conclusions

The construction and installation, O&M, and decommissioning of the Proposed Action would impact invertebrates through several mechanisms, including direct disturbance and mortality from seafloor disturbance during construction, entrainment of eggs and larvae, permanent habitat conversion, and changes in invertebrate community structure and food web interactions caused by reef effects. Reef effects would occur on and around RWF foundations and on portions of the RWEC corridor where cable protection would create new biological hotspots that would benefit some invertebrate species and reduce habitat suitability for others. Benthic infauna and other relatively immobile invertebrates within the 6,656-acre overall disturbance footprint of the Project would unavoidably be injured or killed during Project construction. This impact alone constitutes a **moderate** adverse effect on invertebrate species. Some of these adverse effects would be offset by **moderate** beneficial effects to some invertebrate species that benefit from the reef effects formed by new offshore structures.

Collectively, BOEM anticipates that the overall impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in **moderate** adverse to **moderate** beneficial impacts on invertebrates in the GAA 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.

3.6.2.6 Alternatives C, D, E, and F: Benthic Habitat

3.6.2.6.1 Construction and Installation

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: Alternatives C through F would result in the installation of a reduced total length of IAC and a reduced extent of anchoring impacts relative to the Proposed Action. These alternatives would reduce the overall impact footprint and change the distribution of impacts by benthic habitat type. Differences in the extent of benthic habitat impacts between the Proposed Action and alternate configurations of Alternatives C through E are shown in Table 3.6-11, Table 3.6-12, and Table 3.6-13. The proposed configuration and installation requirements for the RWEC and OSS-link cables would not change under Alternatives C through F; therefore, the difference between impacts presented in each table reflect the reduction in IAC length and reduced anchoring requirements relative to the Proposed Action.

While Alternatives C through F would noticeably reduce the extent of adverse impacts to benthic habitat relative to the Proposed Action, the general scale, nature, and duration of impacts are broadly comparable to those described for the Proposed Action and would therefore be **minor** adverse, applying the impact criteria defined in Section 3.3, Table 3.3-2. However, these criteria do not fully capture the benefits of avoiding long-term impacts to specific habitat types. For example, Alternative C emphasizes avoiding and minimizing impacts to complex benthic habitat and reducing the overall impact footprint. This alternative would reduce overlapping benthic habitat impacts from 5,247 total acres to 3,542 to 3,597 total acres, depending on the configuration selected. Impacts to large-grained complex and complex benthic habitats from vessel anchoring, cable installation and cable protection, seafloor preparation for foundation installation, and the presence of foundations and scour protection would decrease from an estimated 2,214 acres to 1,101 to 1,144 acres, depending on configuration. Impacts to these habitat types would be long term to permanent in duration. Alternatives D and E would similarly reduce the overall footprint of impacts in these habitat types relative to the Proposed Action, from 2,214 acres to 1,763 to 2,135 acres for Alternative D, and from 2,214 to 1,792 to 2,029 acres for Alternative E. However, while total acres of impacts would decrease under each of these alternatives, the proportional distribution of impacts in these habitat types would increase relative to the Proposed Action.

The proposed configurations of Alternative C were developed to avoid impacts to specific high-value complex habitats. Therefore, in addition to the net reduction in impact footprint, the overall footprint and relative distribution of impacts in complex and large-grained complex habitats would decrease relative to the Proposed Action. Moreover, these two alternative configurations would avoid or minimize impacts to the highest-priority habitats identified for protection in the EFH assessment. The distribution of WTG and OSS foundations relative to large-grained complex and complex habitats under the proposed configurations of Alternative C are shown in Appendix L, Figures L-2 and L-3. The differences between alternatives in terms of impacts to habitat suitability for fish species of concern are addressed in greater detail in Section 3.13.2.4.1.

Anchoring and cable installation impacts from Alternative D are broadly similar but noticeably reduced in extent compared to the Proposed Action. The various configurations of Alternative D would reduce the overall benthic habitat impact footprint by 362 to 967 acres relative to the Proposed Action, but the proportional distribution of impacts in large-grained complex habitat would increase (see Table 3.6-12). However, because Alternative D would selectively remove rows of WTG foundations from the perimeter of the RWF, it would not avoid impacts to the high-value large-grained complex and complex habitats in the center of the RWF to the same degree as Alternative C.

Alternative E emphasizes avoidance and minimization of impacts to culturally important viewsheds by removing WTG sites at the north end of the RWF. The affected sites are located predominantly in soft-bottom habitats. Given this, although the two configurations of this alternative would reduce the overall benthic habitat impact footprint by 940 to 1,613 acres and overall impact acreage in large-grained complex and complex habitats compared to the Proposed Action, the proportional distribution of impacts in those habitat types would increase. Alternative E1 would noticeably reduce impacts to large-grained complex and complex habitats by removing some foundation sites from the highest-priority habitats identified for protection in the EFH assessment. In contrast, Alternative E2 would not reduce impacts to these habitats relative to the Proposed Action.

While the initial placement and maintenance of cable protection are elements of this IPF, the concrete mattresses or similar cable protection features are structures that would remain in place throughout the operational life of the Project and would have long-term effects on benthic habitat composition and structure. These effects are addressed in Section 3.6.2.4.2 under presence of structures.

Table 3.6-11. Acres of Benthic Habitat Disturbance from Revolution Wind Export Cable, Offshore Substation-Link Cable, and Inter-Array Cable Installation and Vessel Anchoring and Proportional Distribution of Impacts by Habitat Type under the Proposed Action and Proposed Configurations for Alternative C

Alternative	Maximum Construction Disturbance Footprint (acres)*	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	5,247	14.9%	27.3%	57.8%
C1	3,597	6.2%	24.4%	69.4%
C2	3,542	7.4%	24.9%	67.7%

* Estimated total acres of seafloor disturbance, accounting for overlapping impacts from anchoring disturbance, seafloor preparation, and placement of foundations and scour protection. Anchoring disturbance assumes 13.7 to 21.1 acres of jack-up vessel anchoring for foundation installation, 16.1 acres of pull-ahead anchoring for OSS-link cable and RWEC installation, and 2,320 to 3,167 acres of general construction vessel anchoring impacts based on the number of foundations. The latter could occur anywhere within a 656-foot (200-m) radius around each foundation site. Actual anchoring requirements are not currently known, and certain anchoring activities would overlap; therefore, the impacted habitat footprint would be less than this total area. IAC configurations for Alternatives C through E have not been developed. IAC impacts for these alternatives are based on the same assumption.

Table 3.6-12. Acres of Benthic Habitat Disturbance from Revolution Wind Export Cable, Offshore Substation-Link Cable, and Inter-Array Cable Installation and Vessel Anchoring and Proportional Distribution of Impacts by Habitat Type under the Proposed Action and Proposed Configurations for Alternative D

Alternative	Maximum Construction Disturbance Footprint (acres)*	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	5,247	14.9%	27.3%	57.8%
D1	4,885	15.2%	25.0%	59.7%
D2	4,845	15.7%	26.1%	58.2%
D3	4,885	15.3%	28.4%	56.3%
D1+D2	4,562	16.0%	23.7%	60.3%
D1+D3	4,603	15.6%	26.0%	58.3%
D2+D3	4,562	16.1%	27.3%	56.7%
D1+D2+D3	4,280	16.5%	24.7%	58.8%

* Estimated total acres of seafloor disturbance, accounting for overlapping impacts from anchoring disturbance, seafloor preparation, and placement of foundations and scour protection. Anchoring disturbance assumes 16.6 to 21.1 acres of jack-up vessel anchoring for foundation installation, 16.1 acres of pull-ahead anchoring for OSS-link cable and RWEC installation, and 2,484 to 3,167 acres of general construction vessel anchoring impacts based on the number of foundations. The latter could occur anywhere within a 656-foot (200-m) radius around each foundation site. Actual anchoring requirements are not currently known, and certain anchoring activities would overlap; therefore, the impacted habitat footprint would be less than this total area. IAC configurations for Alternatives C through E have not been developed. Therefore, the benthic habitat impacts presented for Alternative D are based on a hypothetical configuration that underestimates the likely extent and distribution of benthic habitat impacts and are presented here for comparison to impacts from Alternatives C and E. IAC impacts for these alternatives are based on the same assumption.

Table 3.6-13. Acres of Benthic Habitat Disturbance from Revolution Wind Export Cable, Offshore Substation-Link Cable, and Inter-Array Cable Installation and Vessel Anchoring and Proportional Distribution of Impacts by Habitat Type under the Proposed Action and Proposed Configurations for Alternative E

Alternative	Maximum Construction Disturbance Footprint (acres)*	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	5,247	14.9%	27.3%	57.8%
E1	3,634	16.3%	33.0%	50.7%
E2	4,307	16.5%	30.6%	52.9%

* Estimated total acres of seafloor disturbance, accounting for overlapping impacts from anchoring disturbance, seafloor preparation, and placement of foundations and scour protection. Anchoring disturbance assumes 13.5 to 21.1 acres of jack-up vessel anchoring for foundation installation, 16.1 acres of pull-ahead anchoring for OSS-link cable and RWEC installation, and 2,494 to 3,167 acres of general construction vessel impacts based on the number of foundations. The latter could occur anywhere within a 656-foot (200-m) radius around each foundation site. Actual anchoring requirements are not currently known, and certain anchoring activities would overlap; therefore, the impacted habitat footprint would be less than this total

area. IAC configurations for Alternatives C through E have not been developed. Therefore, the benthic habitat impacts presented for Alternative E are based on a hypothetical configuration that underestimates the likely extent and distribution of benthic habitat impacts and are presented here for comparison to impacts from Alternatives C and D.

Presence of structures: Alternatives C through F would result in the installation of fewer monopile foundations than the Proposed Action, resulting in a noticeable reduction in the extent of construction-related impacts on benthic habitat composition and structure. However, the distribution of those impacts would vary by benthic habitat type and habitat priority.

Alternative C seafloor preparation impacts would decrease from approximately 734 acres under the Proposed Action to between 475 and 482 acres depending on configuration selected. Acres of habitat affected by placement of foundations and scour protection would decrease from 81.4 acres to 52.7 to 53.5 acres (see Table 3.6-14). Given this, this alternative would result in an appreciable reduction in the overall impact footprint compared to the Proposed Action. Moreover, the two configurations of Alternative C would distribute those features to minimize impacts to large-grained complex and complex habitats. The proportional distribution of impacts in these habitat types would decrease from a combined 47.5% of the total impact footprint under the Proposed Action to 33.2% to 36.0% under Alternative C (see Table 3.6-14). As stated, these impacts would also be distributed to minimize impacts to the highest priority benthic habitats identified for impact avoidance in the EFH assessment (see Section 3.13.2.7).

Alternatives D and E would also reduce the total impact footprint from foundation installation relative to the Proposed Action. However, the reduction in impact would be smaller, and, unlike Alternative C, these alternatives have not been configured to minimize impacts to high-priority benthic habitats. Differences in the extent of benthic habitat impacts between the Proposed Action and alternate configurations of Alternatives D through E are shown by construction element in Table 3.6-15 and Table 3.6-16. As shown, each configuration would result in a reduced impact footprint. However, because most foundation sites removed are located in soft-bottom habitat, the proportional distribution of impacts in complex and large-grained complex habitat as a percentage of total impact footprint would increase under these alternatives compared to the Proposed Action. Habitat impacts from these alternatives would result in short- to long-term or permanent effects on benthic habitat composition and long-term to permanent effects on benthic habitat structure that extend beyond the footprint of the installed structures. As stated, Alternative F would use one of the configurations described for Alternatives C through E. Therefore, benthic habitat impacts resulting from this alternative would be similar to those resulting from the selected configuration. For example, if Alternative C1 were selected as a model configuration, then the extent and distribution of benthic habitat impacts under Alternative F would be essentially the same as those described for Alternative C1.

The affected areas would eventually regain full habitat function without mitigation, which constitutes a **minor** adverse impact on benthic habitat composition and structure using the impact criteria defined in Section 3.3, Table 3.3-2. As discussed above for anchoring and new cable emplacement and maintenance, the proposed configurations of Alternative C were specifically selected to avoid and minimize impacts to high-priority habitats identified for protection in the EFH assessment. The differences between alternatives in terms of impacts to habitat suitability for fish species of concern are addressed in greater detail in Section 3.13.2.4.1. While installation of foundations, scour, and cable protection occurs during construction, these features would remain in place throughout the operational life of the Project and would have long-term to permanent effects on habitat composition and structure. These effects are described in Section 3.6.2.4.2.

Table 3.6-14. Acres of Benthic Habitat Disturbance from Wind Turbine Generator and Offshore Substation Foundation Installation and Proportional Distribution of Impacts by Habitat Type for the Proposed Action and Proposed Configurations of Alternative C

Alternative	Seafloor Preparation Footprint (acres)*	Monopile Foundations and Scour Protection (acres)†	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	734	81.4	19.0%	29.7%	51.3%
C1	482	53.5	9.7%	23.5%	66.8%
C2	475	52.7	11.7%	24.3%	64.0%

* Revolution Wind estimates that seafloor preparation could be required within approximately 23% of a 656-foot radius around each WTG and OSS foundation, totaling 7.2 acres. The habitat composition shown is based on the mapped habitat composition within a circular seafloor preparation radius of 7.2 acres around each foundation location, and monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively.

† Monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively. An estimated 0.7 acre of rock scour protection would be placed in a circular area around each monopile. All monopile and scour protection impacts occur within the seafloor preparation footprint and are overlapping impacts. This total includes additional impacts from cable protection systems at WTG and OSS foundations that extend beyond the scour protection footprint (approximately 0.07 additional acre per foundation). These impacts will occur within the broader seafloor preparation footprint.

Table 3.6-15. Acres of Benthic Habitat Disturbance from Wind Turbine Generator and Offshore Substation Foundation Installation and Proportional Distribution of Impacts by Habitat Type for the Proposed Action and Proposed Configurations of Alternative D

Alternative	Seafloor Preparation Footprint (acres)*	Monopile Foundations and Scour Protection (acres)†	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	734	81.4	19.0%	29.7%	51.3%
D1	684	75.8	20.0%	25.9%	54.1%
D2	677	75.0	20.2%	28.4%	51.4%
D3	684	75.8	19.7%	31.3%	49.0%
D1+D2	626	69.5	21.4%	24.1%	54.4%
D1+D3	634	70.3	20.9%	27.3%	51.8%
D2+D3	626	69.5	21.1%	30.1%	48.8%
D1+D2+D3	576	63.9	22.5%	25.6%	52.0%

* Revolution Wind estimates that seafloor preparation could be required within approximately 23% of a 656-foot radius around each WTG and OSS foundation, totaling 7.2 acres. The habitat composition shown is based on the mapped habitat composition within a circular seafloor preparation radius of 7.2 acres around each foundation location and monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively.

† Monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively. An estimated 0.7 acre of rock scour protection would be placed in a circular area around each monopile. Monopile and scour protection impacts all occur within the seafloor preparation footprint and are overlapping impacts. This total includes additional impacts from cable protection systems at WTG and OSS foundations that extend beyond the scour protection footprint (approximately 0.07 additional acre per foundation). These impacts will occur within the broader seafloor preparation footprint.

Table 3.6-16. Acres of Benthic Habitat Disturbance from Wind Turbine Generator and Offshore Substation Foundation Installation and Proportional Distribution of Impacts by Habitat Type for the Proposed Action and Proposed Configurations of Alternative E

Alternative	Seafloor Preparation Footprint (acres)*	Monopile Foundations and Scour Protection (acres)†	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	734	81.4	19.0%	29.7%	51.3%
E1	475	52.7	22.5%	39.5%	38.0%
E2	598	66.3	21.6%	34.6%	43.7%

* Revolution Wind estimates that seafloor preparation could be required within approximately 23% of a 656-foot radius around each WTG and OSS foundation, totaling 7.2 acres. The habitat composition shown is based on the mapped habitat composition within a circular seafloor preparation radius of 7.2 acres around each foundation location, and monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively.

† Monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively. An estimated 0.7 acre of rock scour protection would be placed in a circular area around each monopile. All monopile and scour protection impacts occur within the seafloor preparation footprint and are overlapping impacts. This total includes additional impacts from cable protection systems at WTG and OSS foundations that extend beyond the scour protection footprint (approximately 0.07 additional acre per foundation). These impacts will occur within the broader seafloor preparation footprint.

3.6.2.6.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Presence of structures: Alternatives C through F would result in the installation of fewer monopile foundations than the Proposed Action and would reduce the total length of IAC. This would noticeably reduce the extent of long-term to permanent impacts on benthic habitat and habitat-forming invertebrates. However, the alternatives vary appreciably in terms of the extent and distribution of these impacts between benthic habitat types.

Differences between the Proposed Action and alternate configurations of Alternatives C through E in benthic habitat occupied by new structures are shown in Table 3.6-17, Table 3.6-18, and Table 3.6-19. As shown, the two configurations of Alternative C would reduce long-term to permanent impacts from structure presence from approximately 210 acres to 143 to 146 acres compared to the Proposed Action. The proportional distribution of those impacts would also shift toward soft-bottom habitat. Approximately 59.5% of long-term to permanent impacts from structure presence would occur in soft-bottom habitat under the Proposed Action. Under Alternative C, the proportion of impacts in soft-bottom habitat would increase to 68.5% to 70.0% (see Table 3.6-17). Alternative C would also minimize structure presence in the highest-priority habitats identified for impact avoidance in the EFH assessment. Should one of these configurations be selected under Alternative F, that alternative would produce a similar reduction and redistribution of benthic habitat impacts.

Alternatives D and E would also reduce the number of WTG foundations and the total acres of IAC cable relative to the Proposed Action, resulting in a commensurate reduction in the acres of benthic habitat exposed to long-term impacts. Long-term to permanent impacts from structure presence would decrease from approximately 210 acres under the Proposed Action to 173 to 193 acres under Alternative D and to 149 to 171 acres under Alternative E (see Table 3.6-18 and Table 3.6-19). However, the proportional distribution of effects in soft-bottom habitat could increase or decrease, ranging from 58.4% to 63.6%

under Alternative D and from 53.3% to 55.7% under Alternative E compared to 59.5% under the Proposed Action. Should one of these configurations be selected for Alternative F, that alternative would produce a similar impact footprint and distribution of impacts by habitat type.

Alternatives C through F would produce reef and hydrodynamic effects from structure presence similar in nature but reduced in extent relative to those described for the Proposed Action in Sections 3.6.2.2.2 and 3.6.2.3.2. These effects would be reduced in extent under each alternative configuration commensurate with the number of structures and acres of cable protection installed (see Table 3.6-17, Table 3.6-18, and Table 3.6-19 for Alternatives C through E) but would be of the same general scale and overall impact as those produced by the Proposed Action and would therefore be **minor** to **moderate** adverse or **moderate** beneficial, as measured by potential effects on the broader biological community associated with benthic habitats using the significance criteria defined in Section 3.3, Table 3.3-2.

As discussed for Project construction, these impact determinations do not differentiate potentially important differences in impacts between alternatives. Specifically, the proposed configurations of Alternative C were specifically selected to avoid and minimize impacts to large-grained complex and complex habitats of particular value for certain fish species of concern. These potential benefits are acknowledged and discussed in greater detail in terms of potential effects on habitat suitability for certain fish species of concern in Section 3.13.2.4.1.

Table 3.6-17. Acres and Proportional Distribution of Benthic Habitat Affected by the Presence of Wind Turbine Generator and Offshore Substation Foundations and Cable and Scour Protection under the Proposed Action and Proposed Configurations of Alternative C

Alternative	Wind Turbine Generator and Offshore Substation Foundations (total number)	Maximum Seafloor Footprint Occupied by Foundations (acres)*	Cable Protection (acres)†	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	102	81.4	128.2	13.9%	26.6%	59.5%
C1	67	53.5	92.7	6.2%	23.7%	70.0%
C2	66	52.7	90.5	7.7%	23.8%	68.5%

* The habitat composition shown is based on the mapped habitat composition within monopile and scour protection footprints of 0.03 and 0.7 acre and 0.04 and 0.7 acre for the WTG and OSS foundations, respectively. Total includes an additional 0.07 acre per foundation of cable protection system area that extends beyond the scour protection footprint.

† Cable protection would be along 10% of the cable length on the OCS and 14.5% of the cable length in state waters, comprising 4.4 acres for the OSS-link cable and 49.6 acres for the RWEC routes under the Proposed Action. IAC cable protection acres vary by alternative. The precise location of cable protection is not known. Cable protection is most likely to be placed in large-grained complex and complex habitats but could also be required in soft-bottom habitats. Total cable protection acreage varies between alternative configurations based on the number of foundations and IAC length. IAC configurations have not been developed for Alternatives C, D, and E. Cable protection acreage for Alternative C is based on a hypothetical configuration that underestimates the likely extent and distribution of benthic habitat impacts. These values are used as a basis of comparison to impacts from Alternatives D and E.

Table 3.6-18. Acres and Proportional Distribution of Benthic Habitat Affected by the Presence of Wind Turbine Generator and Offshore Substation Foundations and Cable and Scour Protection under the Proposed Action and Proposed Configurations of Alternative D

Alternative	Wind Turbine Generator and Offshore Substation Foundations (total number)	Maximum Seafloor Footprint Occupied by Foundations (acres)*	Cable Protection (acres)†	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	102	81.4	128.2	13.9%	26.6%	59.5%
D1	95	75.8	116.8	11.2%	25.2%	63.6%
D2	96	75.0	116.3	14.2%	25.6%	60.2%
D3	95	75.8	116.8	14.0%	27.6%	58.4%
D1+D2	89	69.5	112.4	14.4%	23.6%	62.1%
D1+D3	88	70.3	113.0	14.2%	25.7%	60.1%
D2+D3	89	69.5	112.4	14.5%	26.7%	58.9%
D1+D2+D3	82	63.9	108.6	11.6%	26.7%	61.7%

* The habitat composition shown is based on the mapped habitat composition within monopile and scour protection footprints of 0.03 and 0.7 acre and 0.04 and 0.7 acre for the WTG and OSS foundations, respectively. Total includes an additional 0.07 acre per foundation of cable protection system area that extends beyond the scour protection footprint.

† Cable protection would be along 10% of the cable length on the OCS and 14.5% of the cable length in state waters, comprising 4.4 acres for the OSS-link cable and 49.6 acres for the RWEC routes under the Proposed Action. IAC cable protection acres vary by alternative. The precise location of cable protection is not known. Cable protection is most likely to be placed in large-grained complex and complex habitats but could also be required in soft-bottom habitat (e.g., at cable crossings). Total cable protection acreage varies between alternative configurations based on the number of foundations and IAC length. IAC configurations have not been developed for Alternatives C, D, and E. Cable protection acreage for Alternative D is based on a hypothetical configuration that underestimates the likely extent and distribution of benthic habitat impacts. These values are used as a basis of comparison to impacts from Alternatives C and E.

Table 3.6-19. Acres and Proportional Distribution of Benthic Habitat Affected by the Presence of Wind Turbine Generator and Offshore Substation Foundations and Cable and Scour Protection under the Proposed Action and Proposed Configurations of Alternative D

Alternative	Wind Turbine Generator and Offshore Substation Foundations (total number)	Maximum Seafloor Footprint Occupied by Foundations (acres)*	Cable Protection (acres)†	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	102	81.4	128.2	13.9%	26.6%	59.5%
E1	66	52.7	95.9	14.9%	30.8%	54.3%
E2	83	66.3	104.4	14.9%	29.3%	55.7%

* The habitat composition shown is based on the mapped habitat composition within monopile and scour protection footprints of 0.03 and 0.7 acre and 0.04 and 0.7 acre for the WTG and OSS foundations, respectively. Cable protection would be placed in complex benthic habitat along 10% of the cable length, totaling 74.1 acres for the IAC, 4.4 acres for the OSS-link cable, and 49.6

acres for the RWEC routes under the Proposed Action. Cable protection acreage would vary between alternative configurations based on IAC length and elimination of the OSS-link cable and RWEC #2 under E1 and E2.

† Cable protection total includes an additional 0.07 acre per foundation of cable protection system footprint extending beyond the scour protection around each foundation. Total cable protection acreage varies between alternative configurations based on the number of foundations and IAC length. IAC configurations have not been developed for Alternatives C, D, and E. Cable protection acreage for Alternative E is based on a hypothetical configuration that underestimates the likely extent and distribution of benthic habitat impacts. These values are used as a basis of comparison to impacts from Alternatives C and D.

3.6.2.6.3 Cumulative Impacts

Offshore Activities and Facilities

The benthic habitat cumulative impacts analysis for Alternatives C, D, E, and F is provided in Table 3.6-3.

3.6.2.6.4 Conclusions

The construction and installation, O&M, and decommissioning of Alternatives C through F would impact benthic habitat through the same mechanisms described for the Proposed Action. Changes in the composition and structure of benthic habitats would occur at specific locations within the RWF and portions of the RWEC corridor where cable protection is used, creating new biological hotspots that would benefit some fish and invertebrate species. Long-term to permanent habitat conversion effects on seafloor from boulder relocation and presence of structures would constitute a **moderate** adverse effect on benthic habitat. Some of these adverse effects would be offset by **moderate** beneficial effects on benthic habitat structure and productivity resulting from reef effects. While the overall extent of offshore impacts to benthic habitat would be reduced under Alternatives C through F relative to the Proposed Action, the overall level of impact would be broadly similar across all alternatives. This finding is specific to impacts to the composition and physical structure of benthic habitat and does not reflect the importance of specific habitats to fish species of particular concern. These effects are addressed in Section 3.13.2.4.1.

Collectively, BOEM anticipates that the overall impacts from offshore activities associated with Alternatives C through F when combined other with past, present, and reasonably foreseeable activities would be similar to the Proposed Action: a **moderate** adverse impact on benthic habitat composition and **moderate** adverse to **moderate** beneficial effects on benthic habitat structure in the GAA.

3.6.2.7 Alternatives C, D, E, and F: Invertebrates

3.6.2.7.1 Construction and Installation

Offshore Activities and Facilities

<u>Noise:</u> Construction of Alternatives C through F would result in similar underwater noise and vibration impacts to invertebrates as those described in Section 3.6.2.3.2 for the Proposed Action, but those impacts would be reduced in extent and duration because fewer foundations would be installed. The total area exposed to noise and vibration effects would vary between alternatives depending on the configuration selected.

Differences in the area of potential exposure to harmful cumulative noise impacts between the Proposed Action and the proposed configurations of Alternatives C through E are summarized in Table 3.6-20, Table 3.6-21, and Table 3.6-22. The values presented in these tables represent 1) the estimated threshold distance from the source for exposure to potentially injurious effects on invertebrate eggs and larvae and behavioral effects on adults, and 2) the difference in the number of sites and total duration of noise-producing activities between alternatives. As shown, while noise effects would vary slightly in extent between layouts; they are similar in magnitude and general scale to the Proposed Action.

As stated in 3.6.2.5.1, UXO detonation is not currently anticipated but could potentially be required should additional devices be identified prior to or during construction. In the event that devices are encountered that require detonation in place, the nature and potential extent of impacts are summarized in Table 3.6-20, Table 3.6-21, and Table 3.6-22. The largest UXO devices are most likely to be found within the central portion of the RWF and in state waters on the RWEC corridor at the mouth and outside of Narragansett Bay (Ordtek 2021), but the probable area of occurrence covers a large enough portion of the RWF such that it is not currently possible to assess potential differences in associated noise impacts between alternatives and the area of potential adverse effects from UXO detonation would be the same across alternatives. Similarly, while reducing the number of foundations and IAC length would also likely reduce HRG survey requirements, insufficient information is available to quantify differences in noise exposure area between alternatives. However, any difference in UXO- or HRG-related noise exposure would not be sufficient to alter the noise impact determination for invertebrates. Applying the impact criteria defined in Section 3.3, Table 3.3-2, construction noise effects on invertebrates from Alternatives C through F would be the same as the Proposed Action: **minor** adverse.

Table 3.6-20. Comparison of Invertebrate Exposure to Construction-Related Noise Impacts between the Proposed Action and Proposed Configurations for Alternative C

Type of Noise Exposure	Activity	Threshold Distance (feet)*	Exposure Parameter	Proposed Action (number)	C1 (number)	C2 (number)
Potentially lethal effects on eggs and larvae	Foundation installation	16–6,000[¥]	No. of sites	102	66	67
			Total days	35	23	23
	UXO detonation	49–1,385[†]	No. of sites	Undetermined[‡]		
Behavioral effects on subadults and adults	Foundation installation	6–1,500[¥]	No. of sites	102	66	67
			Total days	35	23	23
	HRG survey	6	Linear miles	7,386-7,616[Δ]		
			Total days	170-175[Δ]		
	UXO detonation	6–1,500[§]	No. of sites	Undetermined[‡]		

* Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur.

[¥] Threshold distances are anticipated to vary between invertebrate species groups. The low end of ranges represents estimated threshold distances for insensitive species (e.g., crustaceans), and the high end of ranges represents threshold distances for potentially sensitive species (e.g., squid) (Edmonds et al. 2016; Jézéquel et al. 2022; Jones et al. 2020, 2021; Payne et al. 2007).

[†] The safety setbacks derived from Keevan and Hempen (1997) for explosive devices range from 1.1 to 1,000 pounds. UXO detonation impacts could occur anywhere within a 114,769-acre area within the RWF and/or along the RWEC corridor.

[Δ] Survey length and duration estimates assume 3,547 linear miles and 82 days of HRG survey effort for RWEC and OSS-link cables, and 50 HRG survey miles per linear mile of IAC cable at 43 miles of survey effort per day.

[‡] UXO risk mitigation requirements are not currently known; therefore, it is not possible to evaluate differences in detonation requirements between alternatives and alternative configurations.

[§] Available evidence indicates that certain invertebrates, such as crustaceans, are generally insensitive to pressure-related damage from explosions (Keevin and Hempen 1997; Popper et al. 2014). Particle motion effects would likely result in behavioral impacts for individuals in proximity to each detonation. Detonation impacts on invertebrates are therefore anticipated to be generally comparable to impact pile driving.

Table 3.6-21. Comparison of Invertebrate Exposure to Construction-Related Noise Impacts between the Proposed Action and Proposed Configurations for Alternative D

Type of Noise Exposure	Activity	Threshold Distance (feet)*	Exposure Parameter	Number by Alternative							
				Proposed Action	D1	D2	D3	D1+ D2	D1+ D3	D2+ D3	D1+ D2+ D3
Potentially lethal effects on eggs and larvae	Foundation installation	16–6,000[¥]	No. of sites	102	95	94	95	87	88	87	80
			Total days	35	33	33	33	30	31	30	28
	UXO detonation	49–1,385[†]	No. of sites	Undetermined[‡]							
Behavioral effects on subadults and adults	Foundation installation	6–1,500[¥]	No. of sites	102	95	94	95	87	88	87	80
			Total days	35	33	33	33	30	31	30	28
	HRG survey	6	Linear miles	9,279-10,142[Δ]							
			Total days	213-233[Δ]							
	UXO detonation	6–16[§]	No. of sites	Undetermined[‡]							

***** Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur.

[¥] Threshold distances are anticipated to vary between invertebrate species groups. The low end of ranges represents estimated threshold distances for insensitive species (e.g., crustaceans), and the high end of ranges represents threshold distances for potentially sensitive species (e.g., squid) (Edmonds et al. 2016; Jézéquel et al. 2022; Jones et al. 2021; Payne et al. 2007).

[†] The safety setbacks derived from Keevan and Hempen (1997) for explosive devices range from 1.1 to 1,000 pounds. UXO detonation impacts could occur anywhere within a 114,769-acre area within the RWF and/or along the RWEC corridor.

[Δ] Survey length and duration estimates assume 3,547 linear miles and 82 days of HRG survey effort for RWEC and OSS-link cables, and 50 HRG survey miles per linear mile of IAC cable at 43 miles of survey effort per day.

[‡] UXO risk mitigation requirements are not currently known; therefore, it is not possible to evaluate differences in detonation requirements between alternatives and alternative configurations.

[§] Available evidence indicates that certain invertebrates, such as crustaceans, are generally insensitive to pressure-related damage from explosions (Keevin and Hempen 1997; Popper et al. 2014). Particle motion effects would likely result in behavioral impacts for individuals in proximity to each detonation. Detonation impacts on invertebrates are therefore anticipated to be generally comparable to impact pile driving.

Table 3.6-22. Comparison of Invertebrate Exposure to Construction-Related Noise Impacts between the Proposed Action and Proposed Configurations for Alternative E

Type of Noise Exposure	Activity	Threshold Distance (feet)*	Exposure Parameter	Number by Alternative		
				Proposed Action	E1	E2
Potentially lethal effects on eggs and larvae	Foundation installation	16–6,000[¥]	No. of sites	102	66	83
			Total days	35	23	29
	UXO detonation	49–1,385[†]	No. of sites	Undetermined[‡]		
Behavioral effects on subadults and adults	Foundation installation	6–1,500[¥]	No. of sites	102	66	83
			Total days	35	23	29
	HRG survey	6	Linear miles	7,951-8,846[Δ]		
			Total days	183-204[Δ]		
	UXO detonation	6–16[§]	No. of sites	Undetermined[‡]		

* Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur.

¥ Threshold distances are anticipated to vary between invertebrate species groups. The low end of ranges represents estimated threshold distances for insensitive species (e.g., crustaceans), and the high end of ranges represents threshold distances for potentially sensitive species (e.g., squid) (Edmonds et al. 2016; Jézéquel et al. 2022; Jones et al. 2021; Payne et al. 2007).

† The safety setbacks derived from Keevan and Hempen (1997) for explosive devices range from 1.1 to 1,000 pounds. UXO detonation impacts could occur anywhere within a 114,769-acre area within the RWF and/or along the RWEC corridor.

Δ Survey length and duration estimates assume 3,547 linear miles and 82 days of HRG survey effort for RWEC and OSS-link cables, and 50 HRG survey miles per linear mile of IAC cable at 43 miles of survey effort per day.

‡ UXO risk mitigation requirements are not currently known; therefore, it is not possible to evaluate differences in detonation requirements between alternatives and alternative configurations.

§ Available evidence indicates that certain invertebrates, such as crustaceans, are generally insensitive to pressure-related damage from explosions (Keevin and Hempen 1997; Popper et al. 2014). Particle motion effects would likely result in behavioral impacts for individuals in proximity to each detonation. Detonation impacts on invertebrates are therefore anticipated to be generally comparable to impact pile driving.

<u>Sediment deposition and burial:</u> Alternatives C through F would result in sediment deposition and burial impacts on invertebrates, including habitat-forming invertebrates that contribute to benthic habitat structure that are similar but reduced in extent to those described in Section 3.6.2.3.1 for the Proposed Action.

Differences in potential sediment deposition and burial exposure between the Proposed Action and the different configurations proposed for Alternatives C through E are summarized in Table 3.6-23, Table 3.6-24, and Table 3.6-25 in terms of the estimated total acres exposed to sediment deposition and burial effects greater than 0.4 inch (10 mm) for each cable component.

As shown, the various configurations of Alternatives C through F would modify the installation length for the IAC. This would reduce the extent of sediment deposition and burial effects for IAC installation relative to the Proposed Action. Alternative C would also alter the distribution of sediment deposition impacts by avoiding large blocks of complex and large-grained complex habitat, meaning that invertebrates associated with those habitats would be less likely to experience deposition effects. As currently designed, Alternatives C through F would not change the proposed configurations of the OSS-link cable and RWEC; therefore, sediment deposition and burial effects for these Project components would be similar to those produced by the Proposed Action. While these alternatives would result in a slightly smaller area exposed to potentially harmful sediment deposition impacts, the level of impact would be the same as under the Proposed Action. Therefore, short-term sediment deposition and burial effects on invertebrates would range from **negligible** to **minor** adverse.

Table 3.6-23. Comparison of Area Exposed to Sediment Deposition Levels Greater Than 0.4 Inch between the Proposed Action and Proposed Configurations for Alternative C Based on Cable Length

Component	Proposed Action (acres)	C1 (acres)	C2 (acres)
IAC	273	142	142
OSS-link cable	9	9	9
RWEC	3,724	3,724	3,724

Table 3.6-24. Comparison of Area Exposed to Sediment Deposition Levels Greater Than 0.4 Inch between the Proposed Action and Proposed Configurations for Alternative D Based on Cable Length

Component	Proposed Action	D1 (acres)	D2 (acres)	D3 (acres)	D1+D2 (acres)	D1+D3 (acres)	D2+D3 (acres)	D1+D2+ D3 (acres)
IAC	273	231	229	231	214	217	215	201
OSS-link cable	9	9	9	9	9	9	9	9
RWEC	3,724	3,724	3,724	3,724	3,724	3,724	3,724	3,724

Table 3.6-25. Comparison of Area Exposed to Sediment Deposition Levels Greater Than 0.4 Inch between the Proposed Action and Proposed Configurations for Alternative E Based on Cable Length

Component	Proposed Action (acres)	E1 (acres)	E2 (acres)
IAC	273	154	185
OSS-link cable	9	9	9
RWEC	3,724	3,724	3,724

3.6.2.7.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

EMF: Alternatives C through F would result in similar EMF impacts on invertebrates to those described in Section 3.6.2.3.2 for the Proposed Action, but those impacts would be reduced in extent and the total area exposed would vary depending on the configuration selected. Modeled magnetic and induced electrical field effects for buried and exposed cable segments are described in Section 3.6.2.3.2. As shown, these effects vary in magnitude depending on whether the cable is buried to a minimum depth of 3.3 feet (1 m) or is laid on the bed surface under protective armoring. Differences in potential EMF exposure between the Proposed Action and the different configurations proposed for Alternatives C through E are summarized in Table 3.6-26, Table 3.6-27, and Table 3.6-28 in terms of the differences in the total length of buried versus exposed cable segments. While the linear extent of cable-generated EMF effects would decrease, the resulting adverse effects would be of the same intensity and general geographic scale as those produced by the Proposed Alternative, ranging from **negligible** to **minor** adverse.

Presence of structures: As discussed for benthic habitat in Section 3.6.2.4.2, Alternatives C through F would result in the installation of fewer monopile foundations than the Proposed Action and would reduce the total length of IAC. This would noticeably reduce the extent of long-term to permanent impacts on invertebrates, including structure-forming invertebrates associated with benthic habitat.

Differences between the Proposed Action and alternate configurations of Alternatives C through E in benthic habitat occupied by new structures are shown in Section 3.6.2.4.2, Table 3.6-17, Table 3.6-18, and Table 3.6-19. Alternative F would employ one of the proposed Alternative C through E configurations and would otherwise be identical except that it would use higher capacity WTGs. As such, impacts from this IPF would be identical to those described for the selected alternative configuration. As shown, Alternatives C through F would reduce the number of WTG foundations and the total acres of IAC cable relative to the Proposed Action. This would result in a commensurate reduction in the acres of benthic habitat exposed to short- and long-term impacts from the presence of foundations and scour and cable protection and the resulting effects on invertebrates that associate with these habitats.

Alternatives C through F would produce reef and hydrodynamic effects from structure presence similar in nature but reduced in extent relative to those described for the Proposed Action in Section 3.6.2.3.2. The resulting effects on invertebrates would be reduced in extent under each alternative configuration commensurate with the number of structures and acres of cable protection installed (see Table 3.6-17, Table 3.6-18, and Table 3.6-19 for Alternatives C through E) but would be of the same general scale and overall impact as those produced by the Proposed Action. These effects would therefore range from **minor** to **moderate** adverse or **moderate** beneficial, as measured by potential effects on the broader biological community associated with benthic habitats, using the significance criteria defined in Section 3.3, Table 3.3-2.

As discussed for Project construction, these impact determinations do not differentiate potentially important differences in impacts between alternatives. Specifically, the proposed configurations of Alternative C were specifically selected to avoid and minimize impacts to large-grained complex and complex habitats of value for certain fish species of concern. This would in turn reduce the extent of impacts for invertebrate species that associate with complex benthic habitat. These potential benefits are acknowledged and discussed in greater detail in terms of potential effects on habitat suitability for certain fish and EFH invertebrate species of concern in Sections 3.13.2.4.1.

Table 3.6-26. Comparison of Exposure to Electromagnetic Field and Substrate Heating Exposure between the Proposed Action and Proposed Configurations for Alternative C Based on Total Cable Length

Component	Electromagnetic Field Exposure	Proposed Action Cable Length (linear miles)	C1 Cable Length (linear miles)	C2 Cable Length (linear miles)
IAC	Buried to 3.3 feet	139.8	72.8	68.7
	On bed surface	15.5	8.1	7.6
OSS-link cable	Buried to 3.3 feet	8.4	8.4	8.4
	On bed surface	0.9	0.9	0.9
RWEC	Buried to 3.3 feet	70.6	70.6	70.6
	On bed surface	12.7	12.7	12.7

Table 3.6-27. Comparison of Exposure to Electromagnetic Field and Substrate Heating Exposure between the Proposed Action and Proposed Configurations for Alternative D Based on Total Cable Length

Component	Electromagnetic Field Exposure	Proposed Action	D1	D2	D3	D1+D2	D1+D3	D2+D3	D1+D2 +D3
IAC	Buried to 3.3 feet	139.8	118.3	102.7	110.0	117.2	110.0	111.0	118.3
	On bed surface	15.5	13.1	11.4	12.2	13.0	12.2	12.3	13.1
OSS-link cable	Buried to 3.3 feet	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
	On bed surface	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
RWEC	Buried to 3.3 feet	70.6	70.6	70.6	70.6	70.6	70.6	70.6	70.6
	On bed surface	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7

Table 3.6-28. Comparison of Exposure to Electromagnetic Field and Substrate Heating Exposure between the Proposed Action and Proposed Configurations for Alternative E Based on Total Cable Length

Component	Electromagnetic Field Exposure	Proposed Action	E1	E2
IAC	Buried to 3.3 feet	139.8	78.8	95.0
	On bed surface	15.5	8.8	10.6
OSS-link cable	Buried to 3.3 feet	8.4	8.4	8.4
	On bed surface	0.9	0.9	0.9

Component	Electromagnetic Field Exposure	Proposed Action	E1	E2
RWEC	Buried to 3.3 feet	70.6	70.6	70.6
	On bed surface	12.7	12.7	12.7

3.6.2.7.3 Cumulative Impacts

Offshore Activities and Facilities

The invertebrates cumulative impacts analysis for Alternatives C, D, E, and F is provided in Table 3.6-3.

3.6.2.7.4 Conclusions

The construction and installation, O&M, and decommissioning of Alternatives C through F would impact invertebrates through several mechanisms, including short-term and long-term habitat disturbance, permanent habitat conversion, and changes in substrate composition and nutrient cycling from reef effects caused by colonization of structures by habitat-forming invertebrates. These effects would occur on and around the RWF and portions of the RWEC corridor where cable protection is used and create new biological hotspots that would benefit some invertebrate species. Long-term to permanent habitat conversion effects on seafloor from boulder relocation and the presence of structures would constitute a **moderate** adverse effect on invertebrates. Some of these adverse effects would be offset by **moderate** beneficial effects on some invertebrate species that benefit from reef effects. While the overall extent of effects to invertebrates would be reduced under Alternatives C through F relative to the Proposed Action, the significance of those effects would be the same.

Collectively, BOEM anticipates that the overall impacts associated with Alternatives C through F when combined with past, present, and reasonably foreseeable activities would result in **moderate** adverse to **moderate** beneficial impacts on invertebrates in the GAA 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.

3.6.2.8 Alternative G: Impacts of the Preferred Alternative on Benthic Habitat

3.6.2.8.1 Construction and Installation Offshore Activities and Facilities

Offshore Activities and Facilities

<u>Anchoring and new cable emplacement/maintenance:</u> Alternative G would reduce the extent and distribution of impacts from this IPF by decreasing the total length of IAC and the anticipated extent of anchoring impacts relative to the Proposed Action. Differences in the extent of benthic habitat impacts between the Proposed Action and alternate configurations of Alternative G are shown in Table 3.6-29. The proposed configuration and installation requirements for the RWEC and OSS-link cables would not change under Alternative G; therefore, the difference between impacts presented in each table reflect the reduction in IAC length and reduced anchoring requirements relative to the Proposed Action.

While the base Alternative G and Alternatives G1 through G3 would noticeably reduce the extent of adverse impacts to benthic habitat relative to the Proposed Action, the general scale, nature, and duration of impacts are broadly comparable to those described for the Proposed Action and would therefore be

minor adverse, applying the impact criteria defined in Section 3.3, Table 3.3-2. However, these criteria do not fully capture the benefits of avoiding long-term impacts to specific habitat types. For example, Alternative G would reduce impacts in large-grained complex and complex habitats by up to 1,444 acres compared to the Proposed Action. That would include avoidance and minimization of certain high-priority habitats identified in the EFH assessment for the Project.

Table 3.6-29. Acres of Benthic Habitat Disturbance from Revolution Wind Export Cable, Offshore Substation-Link Cable, and Inter-Array Cable Installation and Vessel Anchoring and Proportional Distribution of Impacts by Habitat Type under the Proposed Action and Proposed Configurations for the Alternative G

Alternative	Maximum Construction Disturbance Footprint (acres)*	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	5,247	14.9%	27.3%	57.8%
Alternative G	4,291	6.7%	25.9%	67.4%
Alternative G1†	3,812	5.1%	29.0%	65.4%
Alternative G2†	3,803	5.2%	29.1%	65.3%
Alternative G3†	3.803	5.2%	29.0%	65.3%

* Estimated total acres of seafloor disturbance, accounting for overlapping impacts from anchoring disturbance, seafloor preparation, and placement of foundations and scour protection. Anchoring disturbance assumes 13.5 to 21.1 acres of jack-up vessel anchoring for foundation installation, 16.1 acres of pull-ahead anchoring for OSS-link cable and RWEC installation, and 2,515 to 3,167 acres of general construction vessel anchoring impacts based on the number of foundations. The latter could occur anywhere within a 656-foot (200-m) radius around each foundation site. Actual anchoring requirements are not currently known, and certain anchoring activities would overlap; therefore, the impacted habitat footprint would be less than this total area.

† Approximately 0.5% of impact acreage from IAC installation under Alternatives G1, G2, and G3 would occur in uncategorized habitats.

Presence of structures: Alternative G would result in the installation of fewer monopile foundations than the Proposed Action, resulting in a noticeable reduction in the extent of construction-related impacts on benthic habitat composition and structure. Specifically, seafloor preparation impacts would decrease from approximately 734 acres under the Proposed Action to approximately 583 acres under Alternative G and 482 acres under Alternatives G1 through G3.

Differences in the extent of benthic habitat impacts between the Proposed Action, the base Alternative G, and Alternatives G1 through G3 are shown by construction element in Table 3.6-30. As shown, each configuration would result in seafloor preparation impacts on varying amounts of soft-bottom, complex, and large-grained complex habitats, producing short- to long-term or permanent effects on benthic habitat composition and long-term to permanent effects on benthic habitat structure that extend beyond the footprint of the installed structures.

The affected areas would eventually regain full habitat function without mitigation, which constitutes a **minor** adverse impact on benthic habitat composition and structure using the impact criteria defined in Section 3.3, Table 3.3-2. Alternative G would reduce impacts to high-value large-grained complex and complex habitats compared to the Proposed Action, producing reductions comparable to the two configurations of Alternative C. The meaningful differences between alternatives in terms of impacts to habitat suitability are for fish species of concern and are addressed in greater detail in Section 3.13.2.4.1. While installation of foundations and scour and cable protection occurs during construction, these features would remain in place throughout the operational life of the Project and would have long-term to permanent effects on habitat composition and structure. These effects are described in Section 3.6.2.8.2.

Table 3.6-30. Acres of Benthic Habitat Disturbance from Wind Turbine Generator and Offshore Substation Foundation Installation and Proportional Distribution of Impacts by Habitat Type for the Proposed Action and Proposed Configurations of Alternative G

Alternative	Seafloor Preparation Footprint (acres)*	Monopile Foundations and Scour Protection (acres)†	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	734	81.4	19.0%	29.7%	51.3%
Alternative G	583	64.7	5.4%	30.5%	64.1%
Alternative G1	482	53.5	1.1%	29.1%	69.7%
Alternative G2	482	53.5	1.2%	32.1%	66.7%
Alternative G3	482	53.5	1.2%	32.1%	66.7%

* Revolution Wind estimates that seafloor preparation could be required within approximately 23% of a 656-foot radius around each WTG and OSS foundation, totaling 7.2 acres. The habitat composition shown is based on the mapped habitat composition within a circular seafloor preparation radius of 7.2 acres around each foundation location, and monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively.

† Monopile footprints of 0.03 and 0.04 acre for the WTG and OSS foundations, respectively. An estimated 0.7 acre of rock scour protection would be placed in a circular area around each monopile. All monopile and scour protection impacts occur within the seafloor preparation footprint and are overlapping impacts. This total includes additional impacts from cable protection systems at WTG and OSS foundations that extend beyond the scour protection footprint (approximately 0.07 additional acre per foundation). These impacts will occur within the broader seafloor preparation footprint.

3.6.2.8.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Presence of structures: Alternative G would result in the installation of fewer monopile foundations than the Proposed Action and would reduce the total length of IAC. This would noticeably reduce the extent of long-term to permanent impacts on benthic habitat and habitat-forming invertebrates.

Differences in the extent of benthic habitat occupied by human-made structures between the Proposed Action and Alternative G are shown in Table 3.6-31. As shown, Alternative G would result in a commensurate reduction in the acres of benthic habitat exposed to long-term impacts from the presence of foundations, scour protection, and cable protection, from approximately 210 acres under the Proposed Action to 158 to 174 acres depending on the configuration selected. Alternative G would produce reef and hydrodynamic effects from structure presence similar in nature but reduced in extent relative to those described for the Proposed Action in Sections 3.6.2.2.2 and 3.6.2.3.2. These effects would be reduced in extent under each alternative configuration commensurate with the number of structures and acres of cable protection installed (see Table 3.6-17, Table 3.6-18, and Table 3.6-19 for Alternatives C through E) but would be of the same general scale and overall impact as those produced by the Proposed Action and would therefore be **minor** to **moderate** adverse or **moderate** beneficial, as measured by potential effects on the broader biological community associated with benthic habitats using the significance criteria defined in Section 3.3, Table 3.3-2.

As discussed for Project construction, these impact determinations do not differentiate potentially important differences in impacts between alternatives. Specifically, the proposed configurations of Alternative C were specifically selected to avoid and minimize impacts to large-grained complex and complex habitats of particular value for certain fish species of concern. These potential benefits are acknowledged and discussed in greater detail in terms of potential effects on habitat suitability for certain fish species of concern in Section 3.13.2.4.1.

Table 3.6-31. Acres and Proportional Distribution of Benthic Habitat Affected by the Presence of Wind Turbine Generator and Offshore Substation Foundations and Cable and Scour Protection under the Proposed Action and Proposed Configurations of Alternative G

Alternative	Wind Turbine Generator and Offshore Substation Foundations (total number)	Maximum Seafloor Footprint Occupied by Foundations (acres)*	Cable Protection (acres)†	Large-Grained Complex (%)	Complex (%)	Soft Bottom (%)
Proposed Action	102	81.4	128.2	13.9%	26.6%	59.5%
Alternative G	81	64.7	109.5	5.4%	30.5%	64.1%
Alternative G1	67	53.5	104.8	1.1%	29.1%	69.7%
Alternative G2	67	53.5	104.0	1.2%	32.1%	66.7%
Alternative G3	67	53.5	104.0	1.2%	32.1%	66.7%

* The habitat composition shown is based on the mapped habitat composition within monopile and scour protection footprints of 0.03 and 0.7 acre and 0.04 and 0.7 acre for the WTG and OSS foundations, respectively. Total includes an additional 0.07 acre per foundation of cable protection system area that extends beyond the scour protection footprint.

† Cable protection would be required along 10% of the cable length on the OCS and 14.5% of the cable length in state waters, comprising 4.4 acres for the OSS-link cable and 49.6 acres for the RWEC routes under the Proposed Action. Total cable protection acreage varies between alternative configurations based on the number of foundations and IAC length. Alternative G would require an estimated 50.0 to 55.5 acres of cable protection for the IAC. While precise locations are not yet known, cable protection is most likely to be placed in large-grained complex and complex habitats. However, it will also be used in soft-bottom habitats where required (e.g., at cable crossings).

3.6.2.8.3 Cumulative Impacts

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: Alternative G would result in localized minor to moderate adverse impacts to benthic habitats and invertebrates through an estimated 3,204 acres of anchoring and mooring-related disturbance and 3,452 acres of cabling-related seafloor disturbance within the benthic habitat GAA. Actual anchoring requirements have not been fully specified, and the former represents an overestimate of probable effects. Further, an appreciable portion of anchoring and cable installation impacts would overlap. Therefore, total acres of benthic habitat impacted by this IPF would likely be smaller than the total 6,656 acres from these two sources. Therefore, the Proposed Action when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to benthic habitats and habitat-forming invertebrates based on the same rationale presented for the Proposed Action.

Climate change: The types of impacts from climate change trends described for the No Action Alternative would occur under Alternative G, but Alternative G could also contribute to a long-term net decrease in GHG emissions. This difference may not be measurable but would be expected to help reduce climate change impacts. When combined with other past, present, and reasonably foreseeable actions, climate change trends would result in **moderate** adverse cumulative impacts to benthic habitat and invertebrates under Alternative G.

Presence of structures: Alternative G would result in the installation of 67 new offshore wind energy structures and associated scour and cable protection in the benthic habitat GAA, resulting in the long-term alteration of benthic habitat composition on approximately 189.7 acres of seafloor. That total would comprise approximately 2.3 and 54.3 acres of seafloor displaced by foundations and associated scour protection, respectively; 5.7 acres of cable protection system impacts extending beyond the scour protection footprint; and 120.5 acres affected by cable protection. The foundations would effectively displace benthic habitat, with each foundation replacing 0.03 to 0.04 acre of seafloor with a vertical structure extending from the seafloor to the surface. Impacts to habitat composition from scour and cable protection would vary depending on the type of habitat affected (Causon and Gill 2018; Degraer et al. 2020; Langhamer 2012; Taormina et al. 2018). When placed in soft-bottom habitat, these structures would effectively change the habitat type. When placed in large-grained complex or complex habitats, these structures would either alter the habitat type or modify benthic habitat structure through burial and damage to habitat-forming invertebrates. That habitat structure would recover and would evolve over time into functional benthic habitat as reef effects mature. In all cases, the presence of structures would constitute a long-term to permanent impact to benthic habitat. When reef effects are considered, long-term impacts to benthic habitat composition and structure could be **minor** to **moderate** adverse or **moderate** beneficial depending on how benthic habitat change influences the broader biological community.

Once operational, the WTG and OSS foundations and associated scour protection would produce artificial reef effects that influence benthic habitat structure within and in proximity to the Project footprint. While reef effects would largely be limited to the areas within and in proximity to foundation footprints, the development of individual or contiguous wind energy facilities in nearby areas could produce cumulative effects. For example, large quantities of shell hash created by mussels and other colonizing organisms can alter the composition of soft-bottom sediments in the surrounding area. These alterations in substrate composition would be limited in extent to the area of influence around each foundation but would be long term in duration, as changes in substrate composition from the accumulation of shell hash and altered substrate chemistry would continue to persist after the structures are removed during decommissioning. As such, reef effects from the presence of structures would result in cumulative long-term effects on benthic habitat and would range from **moderate** beneficial to **minor** to **moderate** adverse.

3.6.2.8.4 Conclusions

The construction and installation, O&M, and decommissioning of Alternative G would impact benthic habitat through the same mechanisms described for the Proposed Action, but those effects would be reduced in extent and would be distributed differently in terms of the types of habitats affected. These effects would alter the structure and function of benthic habitats within the maximum work area, including where cable protection is used, and create new biological hotspots that would benefit some fish and invertebrate species.

Long-term to permanent habitat disturbance effects on an estimated 1,740 acres of large-grained complex and complex habitats from vessel anchoring, cable installation and cable protection, seafloor preparation for foundation installation, and the presence of foundation and scour protection would result from Alternative G. An estimated 125 acres of soft-bottom habitat would be converted to hard bottom by the presence of structures, scour protection, and cable protection compared to 131 acres for Alternative G. Collectively, these effects would constitute a **moderate** adverse effect on benthic habitat, resulting from habitat conversion and long-term impacts to certain types of habitat-forming organisms. These adverse effects would be partially offset by **moderate** beneficial effects on benthic habitat structure and productivity resulting from reef effects. The colonization of artificial structures by a complex community of habitat-forming organisms would increase the structural complexity of benthic habitat in and around WTG and OSS foundations. Some benthic habitat effects could persist even after the Project is decommissioned. For example, reef effects would result in shell hash accumulation around foundations that would remain after the structures are removed. This would alter the composition of sediments within the RWF beyond the life of the Project but would not be expected to negatively affect the ability of benthic habitats to support ecosystem function after the Project is decommissioned.

Collectively, BOEM anticipates that the overall impacts from offshore activities associated with Alternative G when combined other with past, present, and reasonably foreseeable activities would result in notable and measurable impacts on benthic habitat. Some of these impacts could persist after the Project is decommissioned, but they would not prevent full recovery of ecosystem function. These findings would constitute a **moderate** adverse impact on benthic habitat composition and **moderate** adverse to **moderate** beneficial effects on benthic habitat structure in the GAA.

3.6.2.9 Alternative G: Impacts of the Preferred Alternative on Invertebrates

3.6.2.9.1 Construction and Installation

Offshore Activities and Facilities

Noise: Construction of Alternative G would result in similar underwater noise and vibration impacts to invertebrates as those described in Section 3.6.2.3.2 for the Proposed Action, but those impacts would be reduced in extent and duration because fewer foundations would be installed.

Differences in the area of potential exposure to harmful cumulative noise impacts between the Proposed Action and Alternative G are summarized in Table 3.6-32. The values presented in this table represents the estimated threshold distance from the source for exposure to potentially injurious effects on invertebrate eggs and larvae and behavioral effects on adults, and the difference in the number of sites and total duration of noise producing activities between alternatives. As shown, while noise effects would vary slightly in extent and duration between layouts; they are similar in magnitude and general scale to the Proposed Action. As summarized in Table 3.6-20, Table 3.6-21, and Table 3.6-22, UXO detonation may be required during site preparation for construction. The largest UXO devices are most likely to be found within the central portion of the RWF and in state waters on the RWEC corridor at the mouth and outside of Narragansett Bay (Ordtek 2021), but the probable area of occurrence covers a large enough portion of the RWF such that it is not currently possible to assess potential differences in associated noise impacts between alternatives and the area of potential adverse effects from UXO detonation would be the same across alternatives. Similarly, while reducing the number of foundations and IAC length would also likely reduce HRG survey requirements, insufficient information is available to quantify differences in the noise exposure area between alternatives. However, any difference in UXO- or HRG-related noise exposure would not be sufficient to alter the noise impact determination for invertebrates. Applying the impact criteria defined in Section 3.3, Table 3.3-2, construction noise effects on invertebrates from Alternative G would be the same as the Proposed Action: **minor** adverse.

Table 3.6-32. Comparison of Invertebrate Exposure to Construction-Related Noise Impacts between the Proposed Action and Proposed Configurations for Alternative G

Type of Noise Exposure	Activity	Threshold Distance (feet)*	Exposure Parameter	Proposed Action	Alternative G	Alternatives G1-G3
Potentially lethal effects on eggs and larvae	Foundation installation	16–6,000[¥]	No. of sites	102	81	67
			Total days	35	28	24
	UXO detonation	49–1,385[†]	No. of sites	Undetermined[‡]		
Behavioral effects on subadults and adults	Foundation installation	6–1,500[¥]	No. of sites	102	81	67
			Total days	35	28	24
	HRG survey	6	Linear miles	8,777-9,457[Δ]		
			Total days	202-219[Δ]		
	UXO detonation	6–16[§]	No. of sites	Undetermined [‡]		

* Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur.

[¥] Threshold distances are anticipated to vary between invertebrate species groups. The low end of ranges are estimated threshold distances for insensitive species (e.g., crustaceans), and the high end of ranges represents threshold distances for potentially sensitive species (e.g., squid) (Edmonds et al. 2016; Jézéquel et al. 2022; Jones et al. 2021; Payne et al. 2007).

[†] The safety setbacks derived from Keevan and Hempen (1997) for explosive devices range from 1.1 to 1,000 pounds. UXO detonation impacts could occur anywhere within a 114,769-acre area within the RWF and/or along the RWEC corridor.

[Δ] Survey length and duration estimates assume 3,547 linear miles and 82 days of HRG survey effort for RWEC and OSS-link cables, and 50 HRG survey miles per linear mile of IAC cable at 43 miles of survey effort per day.

[‡] As of February 2023, 16 UXOs have been identified in the RWEC corridor. None will require detonation. UXO risk mitigation requirements are not currently known; therefore, it is not possible to evaluate differences in detonation requirements between alternatives and alternative configurations.

[§] Available evidence indicates that certain invertebrates, such as crustaceans, are generally insensitive to pressure-related damage from explosions (Keevin and Hempen 1997; Popper et al. 2014). Particle motion effects would likely result in behavioral impacts for individuals in proximity to each detonation. Detonation impacts on invertebrates are therefore anticipated to be generally comparable to impact pile driving.

Sediment deposition and burial: Alternative G would result in sediment deposition and burial impacts on invertebrates, including habitat-forming invertebrates that contribute to benthic habitat structure that are similar but reduced in extent to those described in Section 3.6.2.3.1 for the Proposed Action. Alternative G would reduce total IAC length, reducing the overall footprint of sediment impacts. Alternative G would also reduce cable installation length in sediments with a high proportion of mud and silt from 3.2 to 2.8 miles relative to the Proposed Action.

Differences in potential sediment deposition and burial exposure between the Proposed Action and Alternative G are summarized in Table 3.6-33 in terms of the estimated total acres exposed to sediment deposition and burial effects greater than 0.4 inch (10 mm) for each cable component. As shown, Alternative G would reduce the total acreage exposed to sediment deposition and burial effects above this threshold from 217 to 162 acres relative to the Proposed Action, commensurately reducing the extent of biologically significant sediment burial effects. Alternative G would also alter the distribution of sediment deposition impacts by avoiding large blocks of complex and large-grained complex habitats, meaning that invertebrates associated with those habitats would be less likely to experience deposition effects. As currently designed, Alternative G would not change the proposed configurations of the OSS-link cable and RWEC; therefore, sediment deposition and burial effects for these Project components would be similar to those produced by the Proposed Action. While this alternative would result in a slightly smaller area exposed to potentially harmful sediment deposition impacts, the level of impact would be the same as under the Proposed Action. Therefore, short-term sediment deposition and burial effects on invertebrates would range from **negligible** to **minor** adverse.

Table 3.6-33. Comparison of Area Exposed to Sediment Deposition Levels Greater Than 0.4 Inch between the Proposed Action and Proposed Configurations for Alternative G Based on Cable Length

Component	Proposed Action (acres)	Alternative G (acres)	Alternative G1 (acres)	Alternative G2 (acres)	Alternative G3 (acres)
IAC	273	204	187	184	184
OSS-link cable	9	9	9	9	9
RWEC	3,717	3,717	3,717	3,717	3,717

3.6.2.9.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

EMF: Alternative G would result in similar EMF impacts on invertebrates to those described in Section 3.6.2.3.2 for the Proposed Action, but those impacts would be reduced in extent commensurate with the reduction in IAC length. Modeled magnetic and induced electrical field effects for buried and exposed cable segments are described in Section 3.6.2.3.2. As shown, these effects vary in magnitude depending on whether the cable is buried to a minimum depth of 3.3 feet (1 m) or is laid on the bed surface under protective armoring. Differences in potential EMF exposure between the Proposed Action and the different configurations proposed for Alternatives C through E are summarized in Table 3.6-26, Table 3.6-27, and Table 3.6-28 in terms of the differences in the total length of buried versus exposed cable segments. While the linear extent of cable-generated EMF effects would decrease, the resulting adverse effects would be of the same intensity and general geographic scale as those produced by the Proposed Alternative, ranging from **negligible** to **minor** adverse.

Table 3.6-34. Comparison of Exposure to Electromagnetic Field and Substrate Heating Exposure between the Proposed Action and Proposed Configurations of Alternative G Based on Total Length of Buried and Exposed Cable Segments (linear miles)

Component	Electromagnetic Field Exposure	Proposed Action Cable Length	Alternative G Cable Length (miles)	Alternative G1 Cable Length (miles)	Alternative G2 Cable Length (miles)	Alternative G3 Cable Length (miles)
IAC	Buried to 3.3 feet	139.8	104.5	95.6	94.1	94.1
	On bed surface	15.5	11.6	10.6	10.5	10.5
OSS-link cable	Buried to 3.3 feet	8.4	8.4	8.4	8.4	8.4
	On bed surface	0.9	0.9	0.9	0.9	0.9
RWEC	Buried to 3.3 feet	70.6	70.6	70.6	70.6	70.6
	On bed surface	12.7	12.7	12.7	12.7	12.7

Presence of structures: As discussed for benthic habitat in Section 3.6.2.4.2, Alternative G would result in the installation of fewer monopile foundations than the Proposed Action and would reduce the total length of IAC. This would noticeably reduce the extent of long-term to permanent impacts on invertebrates, including structure-forming invertebrates associated with benthic habitat.

Differences between the Proposed Action and Alternative G in terms of benthic habitat occupied by new structures are shown in Section 3.6.2.8.2, Table 3.6-31. As such, impacts from this IPF would be identical to those described for the selected alternative configuration. As shown, Alternatives C through F would reduce the number of WTG foundations and the total acres of IAC relative to the Proposed Action. This would result in a commensurate reduction in the acres of benthic habitat exposed to short- and long-term impacts from the presence of foundations and scour and cable protection and the resulting effects on invertebrates that associate with these habitats.

Alternatives C through F would produce reef and hydrodynamic effects from structure presence similar in nature but reduced in extent relative to those described for the Proposed Action in Section 3.6.2.3.2. The resulting effects on invertebrates would be reduced in extent commensurate with the number of structures and acres of cable protection installed (see Table 3.6-31) but would be of the same general scale and overall impact as those produced by the Proposed Action. These effects would therefore range from **minor** to **moderate** adverse or **moderate** beneficial, as measured by potential effects on the broader biological community associated with benthic habitats, using the significance criteria defined in Section 3.3, Table 3.3-2.

As discussed for Project construction, these impact determinations do not differentiate potentially important differences in impacts between alternatives. The proposed Alternative G would avoid portions of the RWF composed predominantly of large-grained complex and complex habitats of value for certain fish species of concern. This would in turn reduce the extent of impacts for invertebrate species that associate with complex benthic habitat compared to the Proposed Action. These potential benefits are acknowledged and discussed in greater detail in terms of potential effects on habitat suitability for certain fish and EFH invertebrate species of concern in Section 3.13.2.4.1.

3.6.2.9.3 Cumulative Impacts

Offshore Activities and Facilities

Accidental releases and discharges: Based on compliance with environmental regulations, Alternative G when combined with past, present, and reasonably foreseeable projects would result in negligible adverse cumulative effects on invertebrates from accidental releases and discharges. The rationale for this conclusion is the same as described for the Proposed Action.

When the Project is combined with other future offshore wind projects, up to approximately 34 million gallons of coolants, fuels, oils, and lubricants could cumulatively be stored within WTGs and the OSSs within the invertebrate GAA. All vessels associated with the Proposed Action and other offshore wind projects would comply with USCG requirements for the prevention and control of oil and fuel spills. Additionally, training and awareness of EPMs (see Table G-1 in Appendix G) proposed for waste management and marine debris would be required of RWF Project personnel. These releases, if any, would occur infrequently at discrete locations and vary widely in space and time, and impacts would be minimized through planned EPMs and other mitigation measures detailed in Tables F-1 and F-2, respectively, in Appendix F. Impacts to invertebrates, including habitat-forming species, from small-volume spills are therefore expected to be **negligible** adverse and short term in duration. While unlikely, unanticipated events could result in larger spill events, leading to cumulative impacts of greater severity and duration, similar to those described for the Proposed Action.

Anchoring and new cable emplacement/maintenance: BOEM estimates a cumulative total of 10,520 acres of anchoring and mooring-related disturbance and 104,781 acres of cabling-related disturbance for Alternative G plus all other future offshore wind projects within the invertebrate GAA. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Impacts on soft-bottom benthic habitat and associated fish and invertebrate species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take up to a decade to fully recover.

On this basis, Alternative G when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to invertebrates and on benthic habitat structure through impacts to habitat-forming invertebrates.

Bycatch: Like the Proposed Action, Alternative G would include implementation of the FRMP proposed to evaluate the effects of Project construction and O&M on economically valuable fish and shellfish resources (Revolution Wind and Inspire Environmental 2023). No revisions to the FRMP are proposed based on changes in alternative configuration. As such, cumulative impacts from bycatch associated with monitoring activities under Alternative G in combination with other planned and future offshore wind projects would be **negligible** to **minor** adverse, with the impacts ranging from short term to long term in duration.

Alternative G would also include regular inspections to identify and remove derelict fishing gear and other trash and debris attached to offshore structures. Other future projects are expected to include similar measures in their O&M plans. This O&M effort would benefit invertebrates by removing potential sources of bycatch and benthic habitat structure by removing a source of potential damage to habitat-forming invertebrates. This O&M effort would continue over the life of the Project and other future wind energy projects and would therefore constitute a long-term **minor** beneficial effect on invertebrates and benthic habitat structure.

Climate change: Cumulative impacts to invertebrates and benthic habitat structure from climate change trends under Alternative G are expected to be of similar magnitude to those described for the Proposed Action. As for the Proposed Action, the intensity of climate change cumulative impacts on invertebrates are uncertain but are likely to result in **moderate** adverse effects that vary considerably between species.

EMF: Under Alternative G, the Project would generate EMF and substrate heating effects of varying intensity on up to 198 to 210 miles of combined IAC, OSS-link cable, and RWEC length (compared to 248 miles for the Proposed Action). These effects would combine with those generated by the 13,717 miles of transmission cables from other future offshore wind facilities and existing transmission cables present within the invertebrate GAA. These cumulative effects would be similar in nature to those described for the No Action Alternative in Section 3.6.2.3.2 and the Proposed Action in Section 3.6.2.5.2. In summary, measurable effects on invertebrates from EMF exposure would be limited to individuals that occur in the immediate proximity (i.e., within 20 feet) of Project cables and range from short-term changes in behavior with no significant long-term consequences to potential physiological changes in individuals having prolonged exposure. Substrate heating effects could render small amounts of habitat unsuitable for certain benthic invertebrate species at locations where buried cables are within 2 feet of the bed surface. Effects to individuals are unlikely to have a measurable impact on any invertebrate species at the population level and would therefore range from negligible to minor adverse depending on the type of exposure. BOEM anticipates that future offshore wind energy projects in the invertebrate GAA would use HVAC (versus HVDC) transmission and apply similar design measures to those included in the Proposed Action to avoid and minimize EMF effects on the environment. While uncertainties remain, cumulative adverse impacts to invertebrates from EMF and substrate heating effects resulting from past, planned, and potential future actions are likely to be **minor** adverse.

Light: The Proposed Action would result in noticeable but negligible adverse impacts to invertebrates through the installation of up to 67 lighted structures (65 WTGs and two OSSs). Alternative G and all future projects would be expected to comply with BOEM design guidance for avoiding and minimizing adverse lighting impacts on the environment (BOEM 2021a), meaning that effects to invertebrates would be negligible and adverse. Therefore, the cumulative impacts associated with Alternative G when combined with past, present, and reasonably foreseeable future activities would be similar to those impacts described under the No Action Alternative and would be **negligible** adverse, mostly attributable to existing, ongoing activities.

Noise: Alternative G would generate underwater noise effects during Project construction, throughout the operational life of the Project, and during Project decommissioning. Those impacts would be similar in magnitude and distribution but reduced in extent relative to the Proposed Action. These effects would combine with similar effects resulting from the construction, O&M, and decommissioning of other planned offshore wind projects on the Mid-Atlantic OCS. Sound-sensitive invertebrate species occurring in proximity to impact or vibratory pile driving and/or UXO detonation, if required, could suffer noise-related injury to sensory cells, resulting in reduced survival. The number of individuals affected are unlikely to have any measurable effect on those species at the population level. Less sensitive species may be temporarily disturbed by vibration effects, but any such effects would be short term in duration and are unlikely to have a measurable effect on any invertebrate population. On this basis, cumulative effects on invertebrates resulting from underwater noise caused by Alternative G are likely to be **negligible** to **minor** adverse, varying by species.

Presence of structures: Alternative G would result in long-term alteration of water column and seafloor habitats, resulting in a diversity of effects on benthic habitat and invertebrates, including EFH species. The 67 monopile foundations and other hard surfaces proposed under the configurations of Alternatives G1, G2, and G3 would create an artificial reef effect and cause hydrodynamic effects. The long-term to permanent effects of these structures would influence primary and secondary productivity within and around the artificial reef and influence the distribution and productivity of planktonic invertebrates, eggs, and larvae. Reef effects would alter biological community structure, producing an array of effects on invertebrates. Those cumulative effects could be beneficial or adverse, varying by species, and would likely range from **minor** adverse and beneficial to **moderate** adverse and beneficial in terms of overall impact.

Sediment deposition and burial: Alternative G would result in localized short-term **minor** adverse sediment deposition and burial effects on benthic habitat and invertebrates. Short-term burial effects exceeding 10 mm would occur over an estimated 3,350 acres within the invertebrate GAA, a reduction of approximately 55 acres compared to the Proposed Action. Similar sediment deposition and burial impacts would result from the estimated 104,781 cumulative acres of cabling-related disturbance for Alternative G plus other future offshore wind projects within the invertebrate GAA. When combined with other past, present, and reasonably foreseeable actions, Alternative G would result in **minor** adverse cumulative impacts on benthic habitats and invertebrates based on the same rationale presented for the Proposed Action in Section 3.6.2.5.3.

3.6.2.9.4 Conclusions

The construction and installation, O&M, and decommissioning of Alternative G would impact invertebrates through the same mechanisms described for the Proposed Action, but those impacts would be reduced in extent and would have a different distribution by habitat type. Benthic infauna and other relatively immobile invertebrates within the estimated 5,454-acre overall disturbance footprint of the Project would unavoidably be injured or killed during Project construction. This impact alone constitutes a **moderate** adverse effect on invertebrate species. Some of these adverse effects would be offset by **moderate** beneficial effects to some invertebrate species that benefit from the reef effects formed by new offshore structures.

Collectively, BOEM anticipates that the overall impacts associated with Alternative G when combined with past, present, and reasonably foreseeable activities would result in **moderate** adverse to **moderate** beneficial impacts on invertebrates in the GAA 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.

3.6.2.10 Mitigation

Mitigation measures resulting from agency consultations for benthic habitat and invertebrates are identified in Appendix F, Table F-2, and addressed in Table 3.6-35. Additional mitigation measures identified by BOEM and cooperating agencies are listed in Appendix F, Table F-3, and addressed in Table 3.6-36.

Table 3.6-35. Mitigation and Monitoring Measures Resulting from Consultations for Benthic Habitat and Invertebrates (Appendix F, Table F-2)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
NMFS EFH Conservation Recommendations*	NMFS EFH Conservation Recommendations were issued to BOEM for consideration on June 16, 2023 (NMFS, NOAA, and GARFO 2023). EFH Conservation Recommendations for activities under BOEM's jurisdiction were provided identifying proposed removal and relocation (micrositing) of selected WTG foundations and cable segments removal and relocation; construction timing restrictions to avoid potential adverse impacts to Atlantic cod; habitat alteration minimization; noise mitigation; and minimization of impacts during construction, O&M, and decommissioning. EFH Conservation Recommendations for activities under USACE's jurisdiction were provided for in-water work; offshore impact minimization; impact to scientific surveys minimization; and identification and facilitated access to mapping of relocated boulders, berms, scour, and cable protection.	Implementation of Conservation Recommendations, including eliminating WTG foundations, micrositing WTGs and cable segments, scour protection avoidance, anchoring avoidance, minimizing boulder/cobble relocation distance, and cable re-routing, would minimize known or reasonably foreseeable adverse impacts on benthic habitat and invertebrates, including habitat-forming invertebrates. These measures would reduce impacts to large-grained complex and complex benthic habitats. Conservation recommendations for timing restrictions on all construction activity in the Lease Area from November 1 to April 30, and noise mitigation during construction, such as soft starts, use of noise-dampening equipment, and noise mitigation protocols in consultation with resource agencies prior to construction activities, would avoid and minimize potential noise impacts on invertebrates that have sensitive life stages during the restricted period. Implementation of Conservation Recommendations to revise the Fisheries and Benthic Habitat Monitoring Plan and develop monitoring plans for EMF and operational noise and vibration effects would benefit invertebrates by ensuring robust experimental design, methods, and data collection/analysis to assess changes in habitat conditions. Although implementation of the Conservation Recommendations would provide incremental reductions in impacts on large-grained complex and complex habitats and associated EFH, reductions in the overall impact rating are not anticipated for any of the Proposed Action's IPFs.
Live and hard-bottom impact monitoring	Revolution Wind would develop and implement a monitoring plan for live and hard-bottom features that may be impacted by proposed activities. The monitoring plan would also include assessing the recovery time for these sensitive habitats. BOEM recommends that all monitoring reports classify substrate conditions following Coastal and Marine Ecological Classification Standard (CMECS) standards, including live bottoms (e.g.,	This measure would not modify the impact determination for finfish or EFH or reduce the potential impacts from the project, but it would provide information that can be used to inform the development of future mitigations and/or monitoring programs for the Project and other projects in the region.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	submerged aquatic vegetation and corals and topographic features). The plan would also include a means of recording observations of any increased coverage of invasive species in the impacted hard-bottom areas.	
Live and hard-bottom mapping and avoidance, and impact monitoring	Vessel operators would be provided with maps of sensitive hard-bottom habitat in OSW project areas, as well as a proposed anchoring plan that would avoid or minimize impacts on the hard-bottom habitat to the greatest extent practicable. These plans would be provided for all anchoring activity, including construction, maintenance, and decommissioning.	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would reduce impacts to sensitive and slow-to-recover large-grained complex and complex habitats used by habitat-forming invertebrate species.
Marine debris awareness training	The Lessee would ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: 1) viewing a marine trash and debris training video or slide show (described below) and 2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities must continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process must include the following elements: • Viewing of either a video or slide show by the personnel specified above	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would provide the training, reporting, and enforcement mechanisms necessary to ensure that effects from accidental releases and discharges do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	• An explanation from management personnel that emphasizes their commitment to the requirements • Attendance measures (initial and annual) • Recordkeeping and the availability of records for inspection by DOI By January 31 of each year, the Lessee would submit to the DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE via TIMSWeb with a notification email (at marinedebris@bsee.gov).	
Marine debris elimination	Materials, equipment, tools, containers, and other items used in OCS activities that could be lost or discarded overboard must be clearly marked with the vessel or facility identification. All markings must clearly identify the owner and must be durable enough to resist the effects of the environmental conditions to which they may be exposed. Materials, equipment, tools, containers, and other items used in OCS activities which could be lost or discarded overboard must be properly secured to prevent loss overboard.	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would provide an enforcement mechanism to ensure that effects from accidental releases and discharges do not exceed the levels analyzed herein.
Data collection BA BMPs	BOEM and BSEE would ensure that all Project design criteria and best management practices incorporated in the Atlantic Data Collection Consultation for Offshore Wind Activities (BOEM 2021b) shall be applied to activities associated with the construction, maintenance and operations of the Project as applicable.	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.
Sampling gear	All sampling gear would be hauled out at least once every 30 days, and all gear must be removed from the water and all gear must be removed from the water and stored on land	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would ensure that impacts to sensitive

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	between survey seasons to minimize risk of entanglement.	habitats and species are avoided and minimized to the extent practicable.
Lost survey gear	If any survey gear is lost, all reasonable efforts that do not compromise human safety must be undertaken to recover the gear. All lost gear must be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (via TIMSWeb and notification email at marinedebris@bsee.gov) within 24 hours of the documented time of missing or lost gear. This report must include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would provide a reporting and enforcement mechanism to ensure that impacts to sensitive habitats and species are avoided and minimized to the extent practicable.
Pile-driving restrictions	BOEM would restrict pile driving from January through April, with the addition of December with contingencies. Revolution Wind would be required to develop an adaptive acoustic monitoring plan for spawning Atlantic cod from November through March, including restrictions on Project activities if Atlantic cod aggregations indicative of spawning are detected.	This measure would not modify the impact determination for invertebrates, but it could further avoid and minimize impacts to invertebrate species having sensitive life stages during the expanded contingency period.
Micrositing	All WTG and OSS foundations would be positioned within micrositing windows to avoid impacts to large-grained complex and complex habitats to the extent practicable.	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would ensure that impacts to sensitive habitats and species are avoided and minimized to the extent practicable.
Anchoring plan	BOEM would require Revolution Wind to develop an anchoring plan to avoid minimize adverse impacts on benthic habitat during Project construction and from O&M activities throughout the life of the Project. The anchoring plan must delineate sensitive large-grained complex and complex habitats, including eelgrass and kelp beds, and identify areas where anchoring activities are restricted.	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would effectively minimize long-term impacts to large-grained complex and complex habitats and limit the extent of long-term impacts on habitat-forming invertebrates and benthic habitat structure.
Scour and cable protection	To the extent technically and economically feasible, the Lessee must ensure that all materials used for scour and cable protection consist of natural or engineered stone	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would enhance the quality of artificial habitats created by the installation of scour and cable protection

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	that does not inhibit epibenthic growth. The materials selected for protective purposes should mirror the natural environment and provide similar habitat functions.	through the support of epibenthic growth and the addition of three-dimensional complexity in height and interstitial spaces.
Post-installation cable monitoring	Revolution Wind would be required to inspect all cables after construction is completed to document exact location, burial depth, and post-installation benthic habitat conditions. Inspections must be completed within 6 months of Project commissioning, annually for the first 3 years following construction and as needed following major storm events. Monitoring reports must be submitted to BOEM within 45 days of survey completion.	This measure would not modify the impact determination for benthic habitat or invertebrates, but it would validate the location and burial depth of installed cables and allow for the timely identification of cables that become unburied and pose shallow hazard risks to the resource.
Sound field verification (SFV)	BOEM would require Revolution Wind to develop an SFV plan. The purpose of SFV is to document that modeled acoustic injury threshold distances and associated monitoring requirements are sufficiently protective for sensitive marine species. The SFV process must be sufficient to assess sound propagation from each foundation and attenuation distances to potential injury and harassment thresholds for marine mammals, sea turtles, and fish. To validate the estimated sound field, SFV measurements would be conducted during pile driving of the first three monopiles installed over the course of the Project, with noise attenuation activated. A SFV plan would be submitted to NMFS, BOEM, USACE, and BSEE for review and approval preferably 180 days but no later than 120 days prior to planned start of pile driving. This plan would describe how Revolution Wind would ensure that the first three monopile installation sites selected for sound field are representative of the rest of the monopile installation sites and, in the case that they are not, how additional sites would be selected for SFV. This plan would also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS. The plan	This measure would not modify the impact determination for invertebrates but would provide the information necessary to ensure that these effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	would describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. In the event that Revolution Wind obtains technical information that indicates a subsequent monopile is likely to produce larger sound fields, SFV would be conducted for those subsequent monopiles.	

NMFS EFH Conservation Recommendations were issued to BOEM for consideration on June 16, 2023.

* Information in these rows was taken directly from NMFS (2023) and has not been edited.

Table 3.6-36. Additional Mitigation and Monitoring Measures Under Consideration for Benthic Habitat and Invertebrates (Appendix F, Table F-3)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Anchoring plan	BOEM would require Revolution Wind to develop an anchoring plan to ensure anchoring is avoided and minimized in complex habitats, archaeological resources, and UXOs during Project construction and all O&M activities throughout the operational life of the Project. The anchoring plan is required to be provided for review and comment prior to BOEM approval.	This measure requires that anchoring plan implementation covers O&M and decommissioning activities. It would not modify the impact determination for benthic habitat or invertebrates, but it would help to ensure that long-term impacts to large-grained complex and complex habitats, habitat-forming invertebrates, and benthic habitat structure are effectively minimized.
Post-installation cable monitoring	Revolution Wind must provide BOEM with a cable monitoring report following each IAC and RWEC inspection to determine cable location, burial depths, state of the cable, and site conditions. An inspection of the IAC and RWEC is expected to include HRG methods, such as a multi-beam bathymetric survey equipment, and is expected to identify seafloor features, natural and human-made hazards, and site conditions along federal sections of the cable routing. In federal waters, the initial IAC and RWEC inspection would be carried out within 6 months of commissioning and subsequent inspections would be carried out at years 1, 2, and every 3 thereafter	This measure would not modify the impact determinations for invertebrates but would provide a process to ensure that impacts to benthic habitat and invertebrates are limited to the levels considered in this Final EIS.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	and after a major storm event. Major storm events are defined as when metocean conditions at the facility meet or exceed the 1 in 50-year return period calculated in the metocean design basis, to be submitted to BOEM with the facility design report (FDR). If conditions warrant adjustment to the frequency of inspections following the Year 2 survey, a revised monitoring plan may be provided to BOEM for review. In addition to inspection, the RWEC would be monitored continuously with the as-built Distributed Temperature Sensing System. If distributed temperature sensing data indicate that burial conditions have deteriorated or changed significantly and remedial actions are warranted, the distributed temperature sensing data, a seafloor stability analysis, and report of remedial actions taken or scheduled must be provided to BOEM within 45 calendar days of the observations. The distributed temperature sensing data, cable monitoring survey data, and cable conditions analysis for each year must be provided to BOEM as part of the annual compliance reports, required by 30 CFR 285.633(b).	

3.6.2.10.1 Measures Incorporated into the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.6-35 and in Appendix F, Table F-2, are incorporated into Alternative G (Preferred Alternative). BOEM has also identified the additional measures in Table 3.6-36. These measures, if adopted, would further define how the effectiveness and enforcement of EPMs would be ensured and improve accountability for compliance with EPMs by requiring the submittal of plans for approval by the enforcing agency(ies) and by defining reporting requirements. Because these measures ensure the effectiveness of and compliance with EPMs that are already analyzed as part of the Proposed Action, implementation of these measures would not further reduce the impact level of the Proposed Action from what is described in Section 3.6.2.

3.7 Birds

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to birds from implementation of the Proposed Action and other considered alternatives.

3.8 Coastal Habitats and Fauna

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to coastal habitats and fauna from implementation of the Proposed Action and other considered alternatives.

3.9 Commercial Fisheries and For-Hire Recreational Fishing

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

Geographic analysis area: The GAA for commercial fisheries and for-hire recreational fishing is shown in Figure 3.9-1 and includes all marine waters out to 200 nm offshore that are used by vessels authorized to operate under fisheries managed by the NEFMC, MAFMC, and NMFS Greater Atlantic Regional Fisheries Office (GARFO). In addition, the GAA includes all marine waters of the State of Rhode Island (0–3 nm from the coastline), including landings from fisheries managed by the state. State waters from Maine to the northern portion of South Carolina are also in the GAA, but state water landings are only included if they were made by GARFO-permitted vessels.

Affected environment:

3.9.1.1 Commercial Fisheries

This analysis focuses on commercial fishing activity in the GAA, including the Lease Area and a 1,640-foot-wide corridor centered along the RWEC. The primary data used for this analysis were two batches of summarized vessel trip report (VTR) data provided by NMFS GARFO: 1) data summarizing U.S. Atlantic coastwide landings and revenues (NMFS 2021a) and 2) landings and revenue data specific to areas directly associated with the Project (NMFS 2022a; 2023a). The VTR data include catch estimates by fishing location combined with NMFS estimates of revenue using ex-vessel price data drawn from commercial fisheries dealer reports. VTR data describe most commercial fishing activity in both state and federal waters by vessels that have a federal fishing permit or both a state and federal permit. Fishing vessels with only state permits are not included in the federal VTR data. In addition, vessels with only a federal American lobster permit and no other federal fishery permits do not have a VTR requirement, and many vessels with Atlantic highly migratory species permits also do not have a VTR requirement (NMFS 2021b).[21]

Other sources of catch and effort data used in this analysis were online NMFS resources (NMFS 2021b, 2022a, 2023b), which contain commercial fisheries data for each proposed WEA on the U.S. Atlantic Coast. In addition, this analysis includes 1) figures showing the directionality of VMS-enabled fishing vessels developed by BOEM based on data provided by NMFS (2019), and 2) figures showing the distribution of fishing revenue intensity that were adapted from maps in NMFS (2020).

This analysis predominantly uses 2008–2019 fisheries data. For comparative purposes, Tables G-CF62 through G-CF65 in Appendix G present commercial fishing revenue information for the 1) Lease Area and 2) Lease Area and along the RWEC under Alternative G based on the data for 2008–2019 and 2008–2021.

[21] Under the Jonah Crab FMP, participation in the directed Jonah crab fishery is tied to a American lobster permit. As a result, the FMP extends the reporting requirements in the lobster fishery to the Jonah crab fishery (Atlantic States Marine Fisheries Commission 2018). According to BOEM (2022), species like Jonah crab and lobster have good representation in the GARFO data in southern New England, which include the GAA for commercial fisheries and for-hire recreational fishing.

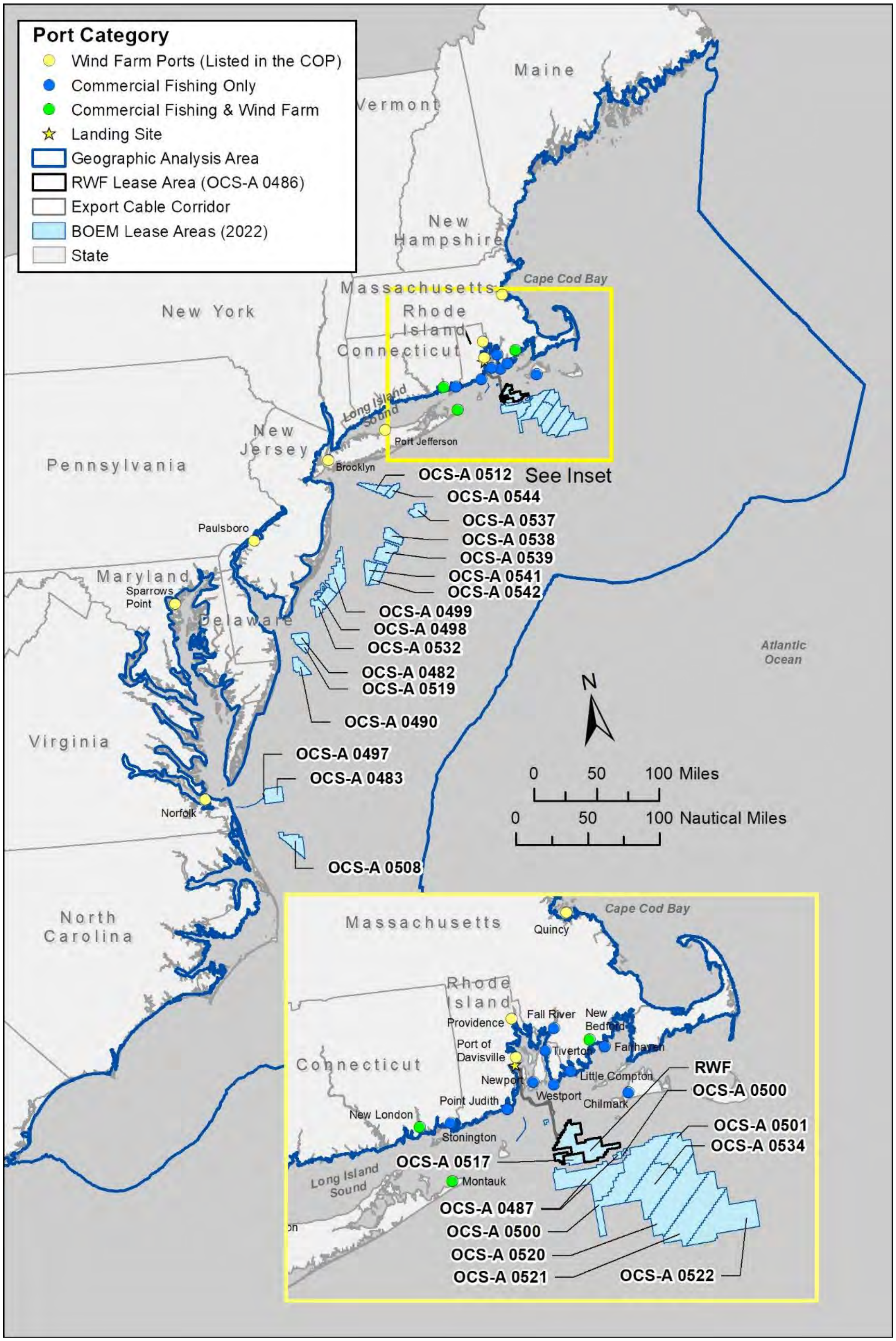


Figure 3.9-1. Geographic analysis area for commercial fisheries.

To understand the relative importance of the Lease Area and RWEC corridor to fisheries in the Mid-Atlantic and New England regions, the commercial fishing revenue sourced from each area is compared to the total commercial fishing revenue reported by GARFO for federally permitted commercial fishing activity in the Mid-Atlantic and New England regions. These two regions include all coastal states from Maine to North Carolina. In addition, to provide a more localized geographical context, the analysis describes commercial fishing revenue in the Regional Fisheries Area (RFA) for the Project, which comprises Greater Atlantic Region Statistical Areas 537, 538, 539, 611, and 613. The description of commercial fishing in the RFA also includes a discussion of the area of high-value fisheries that was excluded by BOEM from possible leasing for wind energy development in order to reduce conflict with both commercial and recreational fishing activities.

To the extent that data are available, the commercial fishing described here includes federally permitted fishing activity in both state and federal waters. Data on the average annual revenue of federally permitted vessels by fishery management plan (FMP) fishery (i.e., a fishery managed under a federal FMP), gear type, and port of landing are summarized in the tables in this section. Fishing revenue intensity maps for 2016 through 2018 are provided in Appendix G for 12 FMP fisheries. Appendix G also includes a figure of the distribution of all fishing revenue for 2013 through 2015. In general, the data presented focus on those FMP fisheries, species, gear types, and ports that are relevant to commercial fishing activity in the Lease Area and along the RWEC. Additional details on the data sources and methodology used to develop the tables and figures are provided in Appendix G.

3.9.1.1.1 Mid-Atlantic and New England Regional Setting

Commercial fisheries operating in federal waters off the Mid-Atlantic and New England regions are known for large catches of a variety of species, including Atlantic herring (*Clupea harengus*), surfclam (*Spisula solidissima*), quahog (*Arctica islandica*), squid (Decapodiformes), sea scallop (*Placopecten magellanicus*), skates (Rajidae), summer flounder (*Paralichthys dentatus*), monkfish (*Lophius americanus*), lobster (*Homarus americanus*), Jonah crab (*Cancer borealis*), and various groundfish species.[3]. These fishery resources are harvested with an assortment of fishing gear, including mobile gear (e.g., bottom trawl, dredge, and midwater trawl) and fixed gear (e.g., gillnet, pot, bottom longline, seine, and hand line), and are managed under several FMPs[22]:

- Atlantic Sea Scallop FMP, Monkfish FMP, Northeast Multispecies (large- and small-mesh) FMP,[23] Northeast Skate Complex FMP, Atlantic Herring FMP, and Red Crab FMP (NEFMC 2022)
- Surfclam/Ocean Quahog FMP, Mackerel/Squid/Butterfish FMP, Spiny Dogfish FMP, Bluefish FMP, Golden and Blueline Tilefish FMP, Summer Flounder/Scup/Black Sea Bass FMP, and River Herring FMP (MAFMC 2023)

[22] These FMP fisheries are referred to frequently throughout the EIS, and therefore the author-date citations are provided here at first mention only.

[23] The Northeast Multispecies (large-mesh) FMP fishery is composed of the following groundfish species: Atlantic cod, haddock, Atlantic pollock, yellowtail flounder, witch flounder, winter flounder, windowpane flounder, American plaice (*Hippoglossoides platessoides*), Atlantic halibut (*Hippoglossus hippoglossus*), Acadian redfish (*Sebastes fasciatus*), Atlantic wolffish (*Anarhichas lupus*), ocean pout, and white hake (*Urophycis tenuis*). The Northeast Multispecies small-mesh FMP fishery is composed of five stocks of three species of hakes: northern silver hake and southern silver hake (*Merluccius bilinearis*), northern red hake and southern red hake (*Urophycis chuss*), and offshore hake (*Merluccius albidus*). Southern silver hake and offshore hake are often grouped together and collectively referred to as “southern whiting.”

- Consolidated Atlantic Highly Migratory Species FMP(NMFS 2006)
- Lobster FMP and Jonah Crab FMP (Atlantic States Marine Fisheries Commission [ASMFC] 2023)[24]

One way that fishery resources contribute to regional economies is through direct ex-vessel revenue or through revenue generated when a commercial fishing boat lands or unloads a catch. Table 3.9-1 shows the average annual revenue by FMP fishery (sorted alphabetically) from 2008 through 2019, the time period for which the most recent data are available. Although there is substantial variability in the year-to-year harvest of various species, on average, federally permitted commercial fishing activity generated approximately $952.4 million in average revenue annually from 2008 through 2019, with the Atlantic Sea Scallop FMP fishery accounting for more than half (54%) of the total, the American Lobster FMP fishery accounting for 10% of the total, and the Northeast Multispecies (large-mesh) FMP fishery accounting for 8% of the total. “Other FMPs, non-disclosed species, and non-FMP fisheries” accounted for 10% of the total average annual revenue.

Table 3.9-1. Commercial Fishing Revenue of Federally Permitted Vessels in Mid-Atlantic and New England Fisheries by FMP Fishery (2008–2019)

FMP Fishery	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)
American Lobster	$117,251.0	$93,250.1
Atlantic Herring	$32,856.3	$25,929.7
Bluefish	$1,820.4	$1,275.3
Golden and Blueline Tilefish	$6,583.4	$5,553.9
Highly Migratory Species	$4,008.4	$2,219.4
Jonah Crab	$17,082.7	$9,607.8
Mackerel/Squid/Butterfish	$74,576.6	$51,911.7
Monkfish	$28,943.7	$20,597.3
Northeast Multispecies (large-mesh)	$105,418.2	$73,331.4
Northeast Multispecies (small-mesh)	$13,499.5	$11,261.1
Atlantic Sea Scallop	$661,233.5	$518,891.6
Northeast Skate Complex	$10,217.1	$7,448.4
Spiny Dogfish	$5,237.2	$2,975.4

[24] The regional setting includes the jurisdictions of two regional fishery management councils created under the Magnuson-Stevens Fishery Conservation and Management Act: the MAFMC manages fisheries in federal waters off the coasts of New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina, and the NEFMC manages fisheries in federal waters off the coasts of Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut. The two councils manage species with many FMPs that are frequently updated, revised, and amended, and they coordinate with each other to jointly manage species across jurisdictional boundaries. Some of the managed fisheries of each council extend into state waters. Therefore, the councils work with the ASMFC, which comprises the 15 Atlantic Coast states and coordinates the management of marine and anadromous resources found in the states’ marine waters. In addition, the lobster and Jonah crab fisheries are cooperatively managed by the states and the NMFS under the framework of the ASMFC (ASMFC 2023).

FMP Fishery	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)
Summer Flounder/Scup/Black Sea Bass	$45,205.7	$39,807.4
Surfclam/Ocean Quahog	$63,152.0	$60,087.2
Other FMPs, non-disclosed species and non-FMP fisheries*	$33,646.8	$28,290.4
Total	$1,132,912.7	$952,438.3

Source: Developed using data from NMFS (2021a).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows, including the Total row.

* The "Other FMPs, non-disclosed species, and non-FMP fisheries" category includes revenue from two FMP fisheries: Red Crab and River Herring. It also includes a) revenue from species in FMP fisheries for which data could not be disclosed due to confidentiality restrictions and b) revenue earned by federally permitted vessels operating in fisheries that are not federally managed.

Table 3.9-2 shows the average annual landings for the top 20 FMP fishery species by weight from 2008 through 2019. Atlantic herring and sea scallop accounted for 41% and 13% of the total landings, respectively, whereas *Loligo* squid and skates each accounted for 6%.

Table 3.9-2. Commercial Fishing Landings of Federally Permitted Vessels in Mid-Atlantic and New England Fisheries by Top 20 Species (2008–2019)

Species	FMP Fishery	Peak Annual Landings (pounds)	Average Annual Landings (pounds)
American lobster	American Lobster	22,227,430	19,334,031
Atlantic herring	Atlantic Herring	217,820,607	155,541,858
Atlantic mackerel	Mackerel/Squid/Butterfish	48,873,977	18,789,264
Black sea bass	Summer Flounder/Scup/Black Sea Bass	3,093,459	1,806,872
Bluefish	Bluefish	2,886,624	1,825,725
Butterfish	Mackerel/Squid/Butterfish	7,852,044	3,242,538
Cod	Northeast Multispecies (large-mesh)	16,920,601	7,477,847
Jonah crab	Jonah Crab	17,874,506	11,855,186
Loligo squid	Mackerel/Squid/Butterfish	38,654,405	24,653,366
Monkfish	Monkfish	12,188,795	9,732,966
Red hake	Northeast Multispecies (small-mesh)	1,908,985	1,357,856
Rock crab	No federal FMP	3,707,631	943,811
Scup	Summer Flounder/Scup/Black Sea Bass	14,551,815	10,859,288
Sea scallop	Atlantic Sea Scallop	59,057,105	49,948,027

Species	FMP Fishery	Peak Annual Landings (pounds)	Average Annual Landings (pounds)
Silver hake	Northeast Multispecies (small-mesh)	17,316,860	14,078,640
Skates	Northeast Skate Complex	26,811,281	21,310,278
Spiny dogfish	Spiny Dogfish	22,843,386	13,376,198
Summer flounder	Summer Flounder/Scup/Black Sea Bass	14,999,293	9,289,256
Winter flounder	Northeast Multispecies (large-mesh)	5,875,684	3,631,996
Yellowtail flounder	Northeast Multispecies (large-mesh)	3,915,379	2,172,206

Source: Developed using data from NMFS (2021a).

Notes: The table shows landings of the top 20 species landed (by pounds) in the combined Lease Area and RWEC.

Table 3.9-3 shows the average annual revenue by gear type from 2008 through 2019 (sorted alphabetically). Scallop dredge gear accounted for 51% of the revenue generated by all gear in the Mid-Atlantic and New England regions. Bottom trawl gear and pot gear (including pot gear used in the Lobster FMP fishery) also each generated over $115 million in average annual revenue.

Table 3.9-3. Commercial Fishing Revenue of Federally Permitted Vessels in Mid-Atlantic and New England Fisheries by Gear Type (2008–2019)

Gear Type	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)
Dredge-clam	$65,768.2	$61,333.5
Dredge-scallop	$615,168.5	$489,410.9
Gillnet-sink	$44,624.9	$30,031.6
Handline	$6,222.2	$4,754.5
Pot-other	$146,203.6	$115,055.2
Trawl-bottom	$229,153.5	$187,199.3
Trawl-midwater	$26,600.8	$18,995.8
All other gear*	$62,406.3	$47,305.8
Total	**$1,135,221.1**	**$954,086.5**

Source: Developed using data from NMFS (2021a).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows including the Total row.

* Includes revenue from federally permitted vessels using longline gear, seine gear, other gillnet gear, and unspecified gear, as well as listed gear for years when they were not disclosed.

Commercial fishing fleets are important to coastal communities in the Mid-Atlantic and New England regions because they generate employment and income for vessel owners and crews, as well as create demand for shoreside products and services to maintain vessels and process seafood. In 2017, total seafood landings in the Mid-Atlantic and New England regions, including landings from non-federally permitted vessels, were valued at $1.80 billion. The regions are also home to aquaculture production and research that provide employment and business opportunities for coastal communities. In New England, the seafood industry generated $5.6 billion in personal and proprietor income, whereas that impact totaled $3.8 billion in the Mid-Atlantic (NMFS 2021d).

Table 3.9-4 shows the average annual revenue by port of landing from 2008 through 2019.[25] New Bedford accounted for approximately 40% of the total commercial fishing revenue in the Mid-Atlantic and New England regions, and Cape May and Narragansett/Point Judith accounted for 9% and 5%, respectively.

[25] The ports shown are the 16 ports (or port groups) that had disclosed revenue and landings data received from NMFS (2022b) from within the Lease Area and/or along the RWEC for at least five of the 12 years from 2008 through 2019.

Table 3.9-4. Commercial Fishing Revenue of Federally Permitted Vessels in Mid-Atlantic and New England Fisheries and Level of Fishing Dependence by Port

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Commercial Fishing Engagement Categorical Ranking*	Commercial Fishing Reliance Categorical Ranking†
Beaufort, NC	$5,210.8	$2,654.1	High	Medium
Chilmark/Menemsha, MA‡	$656.1	$470.9	Medium	High
Fairhaven, MA	$17,395.3	$11,282.5	High	Low
Fall River, MA	*$5,123.6*	*$1,135.6*	*Medium*	*Low*
Hampton, VA	$19,482.0	$14,379.2	High	Low
Little Compton, RI	$3,007.4	$1,992.2	Medium	Medium
Montauk, NY	$24,549.9	$18,496.4	High	Medium
New Bedford, MA	$458,246.7	$378,792.6	High	Medium
New London, CT	$11,117.1	$6,646.6	Medium–High	Low
Newport News, VA	$54,540.1	$30,970.8	High	Low
Newport, RI	$16,111.1	$8,896.3	High	Low
Point Judith, RI	$58,531.0	$46,076.7	High	Medium
Point Pleasant Beach, NJ	$37,321.9	$30,986.2	High	Medium
Stonington, CT	$11,946.4	$10,273.8	High	Low
Tiverton, RI	$1,603.1	$1,148.8	Medium	Low
Westport, MA	$1,905.8	$1,305.2	Low	Low
Revenues by Port State‡‡				
All Connecticut ports	$23,063.5	$16,983.9	N/A	N/A
All Massachusetts ports	$598,628.2	$498,180.5	N/A	N/A
All New Jersey ports	$236,221.6	$173,939.2	N/A	N/A

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Commercial Fishing Engagement Categorical Ranking*	Commercial Fishing Reliance Categorical Ranking†
All New York ports	$57,846.0	$32,406.4	N/A	N/A
All Rhode Island ports	$83,083.4	$68,916.3	N/A	N/A
Ports in all other states	$153,530.8	$116,778.7	N/A	N/A
Port data withheld for confidentiality§	$64,272.8	$46,227.3	N/A	N/A
Total	**$1,135,221.1**	**$953,432.4**	N/A	N/A

Source: NEFMC (2021); NMFS (2021a)

Notes: Commercial fishing revenue data are from 2008 through 2019; levels of fishing dependency are for 2018. Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows, including the Total row. Ports shown in *italics* indicate that fewer than 12 years but more than 4 years of data were used to calculate the estimates.

MA = Massachusetts, MD = Maryland, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia.

* Commercial fishing engagement measures the presence of commercial fishing through fishing activity as shown through permits, fish dealers, and vessel landings. A high rank indicates more engagement. N/A indicates that no information is available.

† Commercial fishing reliance measures the presence of commercial fishing in relation to the population size of a community through fishing activity. A high rank indicates more reliance. N/A indicates that no information is available.

‡ Reported landings are divided evenly between the two communities.

‡‡ Revenues by Port State include all of the revenues by the ports listed above, as well as revenues of other ports within the state that were reported by NMFS, but which had 4 or fewer years of data and were not included in the table.

§ Includes data for all ports that were withheld by NMFS to protect the confidentiality of individual vessels and/or buyers.

Table 3.9-4 also presents the level of commercial fishing engagement and reliance of the community in which the port is located. These rankings portray the level of dependence the community has on commercial fishing. As shown in the table, the rankings differ across communities, with Cape May ranking high for both commercial fishing engagement and reliance, and Westport ranking low for the two indices. Information regarding how the rankings were determined for each community is provided in the community profiles available at NEFMC (2021). These profiles present the most recent data available for key indicators for Mid-Atlantic and New England fishing communities related to dependence on fisheries and other economic and demographic characteristics. Selected socioeconomic characteristics of communities with fishing ports that could be affected by the Project are also presented in Section 3.11 and Section 3.12. Additional community-specific information on the historic, demographic, cultural, and economic context for understanding the involvement in fishing of the communities included in this analysis can be found in Colburn et al. (2010).

3.9.1.1.2 Regional Fisheries Area

The Lease Area and RWEC are located in the RFA, which, as noted above and shown in Figure 3.9-2, includes Greater Atlantic Region Statistical Areas 537, 538, 539, 611, and 613.

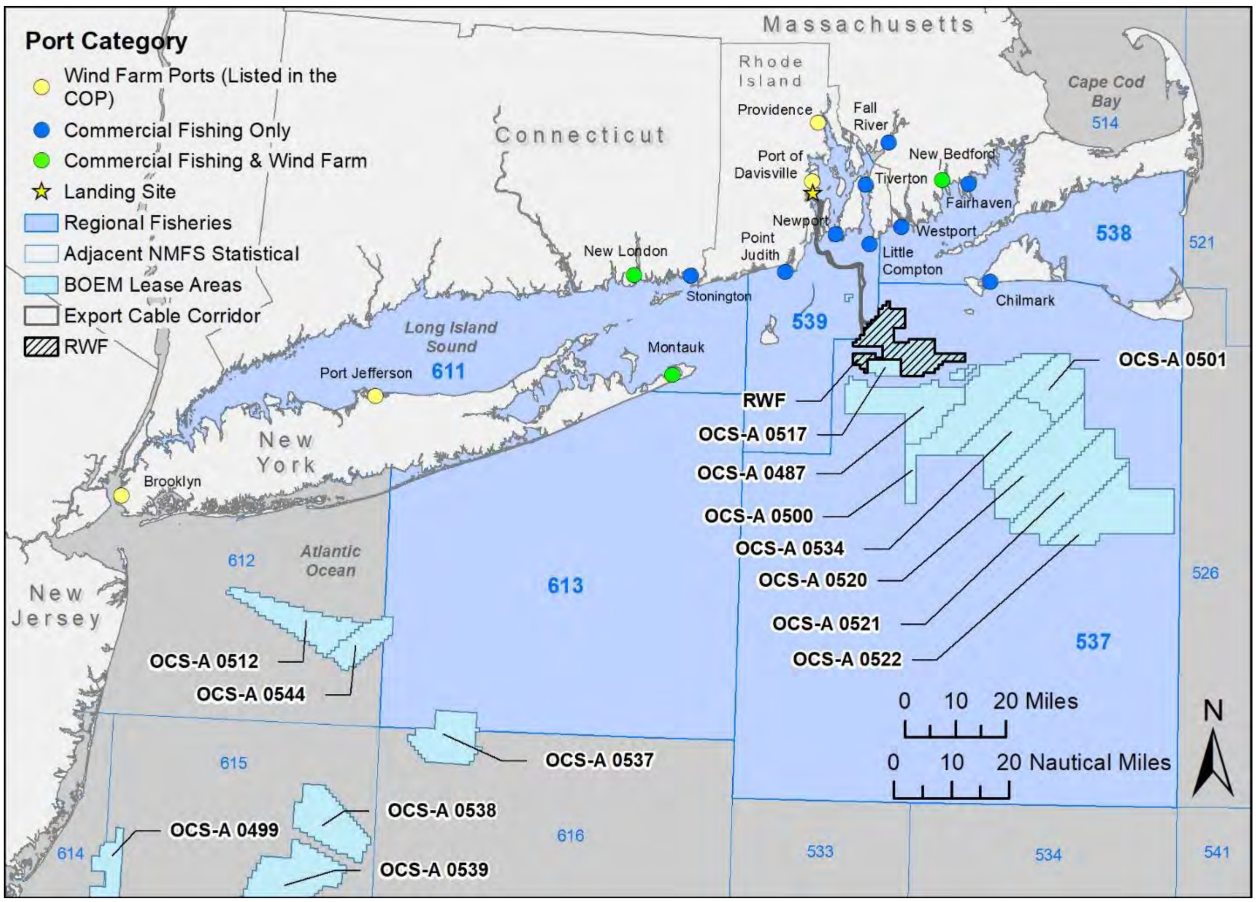


Figure 3.9-2. Regional Fisheries Area.

Table 3.9-5 shows the average annual revenue in the RFA by FMP fishery from 2008 through 2019. On average, federally permitted commercial fishing activity in the RFA annually generated $143.9 million in revenue, with the Atlantic Sea Scallop FMP fishery accounting for 35% of the total, the Mackerel/Squid/Butterfish FMP fishery accounting for 11% of the total, and the Summer Flounder/Scup/Black Sea Bass FMP fishery accounting for 8% of the total. "Other FMPs, non-disclosed species, and non-FMP fisheries" accounted for 23% of the average annual revenue for all FMP and non-FMP fisheries. Table 3.9-5 also shows the percentage of each FMP fishery's total revenue in the Mid-Atlantic and New England regions that came from the RFA from 2008 through 2021. The RFA accounted for a large share of the total revenue of the Jonah Crab FMP fishery (61%), Northeast Skate Complex FMP fishery (48%), Bluefish FMP fishery (46%), and Monkfish FMP fishery (36%). Across all FMP and non-FMP fisheries, the RFA accounted for approximately 15% of the total revenue in the Mid-Atlantic and New England regions.

Table 3.9-5. Commercial Fishing Revenue of Federally Permitted Vessels in the Regional Fisheries Area by FMP Fishery (2008–2019)

FMP Fishery	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*
American Lobster	$11,498.0	$7,799.0	8.4%
Atlantic Herring	$6,853.8	$2,994.1	11.5%
Bluefish	$816.3	$582.6	45.7%
Highly Migratory Species	$315.5	$219.7	9.9%
Jonah Crab	$11,244.6	$5,871.9	61.1%
Mackerel/Squid/Butterfish	$29,544.7	$15,424.7	29.7%
Monkfish	$11,610.7	$7,520.2	36.5%
Northeast Multispecies (large-mesh)	$4,616.6	$2,389.4	3.3%
Northeast Multispecies (small-mesh)	$3,928.6	$2,823.6	25.1%
Atlantic Sea Scallop	$107,023.3	$49,741.2	9.6%
Northeast Skate Complex	$5,671.1	$3,579.6	48.1%
Spiny Dogfish	$546.8	$244.0	8.2%
Summer Flounder/Scup/Black Sea Bass	$14,327.2	$10,999.8	27.6%
Other FMPs, non-disclosed species, and non-FMP fisheries†	$42,517.3	$33,757.3	N/A
Total	**$213,098.9**	**$143,947.2**	**15.1%**

Source: Developed using NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows including the Total row.

* See Table 3.9-1 for Mid-Atlantic and New England fisheries data by FMP fishery.

† The "Other FMPs, non-disclosed species, and non-FMP fisheries" category includes revenue from three FMP fisheries: Surfclam/Ocean Quahog, Red Crab, and River Herring. It also includes a) revenue from species in FMP fisheries for which data could not be disclosed due to confidentiality restrictions and b) revenue earned by federally permitted vessels operating in fisheries that are not federally managed.

Table 3.9-6 shows the average annual landings by individual species from 2008 through 2019. The top three species were Atlantic herring, skates, and *Loligo* squid accounting for 27%, 16%, and 12% of the total landings, respectively. Table 3.9-6 also shows the percentage of each species' total landings in the Mid-Atlantic and New England regions that came from the RFA from 2008 through 2019. The RFA accounted for a large share of the total landings of rock crab (71%), skates (65%), scup (65%), Jonah crab (54%), red hake (*Urophycis chuss*) (48%), monkfish (44%), *Loligo* squid (41%), butterfish (38%), and summer flounder (37%).

Table 3.9-6. Commercial Fishing Landings of Federally Permitted Vessels in the Regional Fisheries Area by Species (2008–2019)

Species	FMP Fishery	Peak Annual Landings (pounds)	Average Annual Landings (pounds)	Average Annual Landings as a Percentage of Total Landings in the Mid-Atlantic and New England Regions*
American lobster	American Lobster	1,930,635	1,334,642	6.9%
Atlantic herring	Atlantic Herring	49,580,526	23,065,828	14.8%
Atlantic mackerel	Mackerel/Squid/Butterfish	16,142,814	2,803,012	14.9%
Black sea bass	Summer Flounder/Scup/Black Sea Bass	944,309	422,898	23.4%
Bluefish	Bluefish	1,000,463	730,175	40.0%
Butterfish	Mackerel/Squid/Butterfish	2,761,688	1,230,067	37.9%
Cod	Northeast Multispecies (large-mesh)	386,358	201,932	2.7%
Jonah crab	Jonah Crab	10,396,456	6,372,109	53.7%
Loligo squid	Mackerel/Squid/Butterfish	21,451,952	10,224,109	41.5%
Monkfish	Monkfish	4,975,969	4,302,449	44.2%
Red hake	Northeast Multispecies (small-mesh)	1,030,911	658,114	48.5%
Rock crab	Other FMPs, non-disclosed species and non-FMP fisheries	3,042,399	667,393	70.7%
Scup	Summer Flounder/Scup/Black Sea Bass	9,912,424	7,105,610	65.4%
Sea scallop	Atlantic Sea Scallop	11,529,926	4,685,271	9.4%
Silver hake	Northeast Multispecies (small-mesh)	5,527,656	3,557,841	25.3%
Skates	Northeast Skate Complex	15,472,505	13,964,696	65.5%

Species	FMP Fishery	Peak Annual Landings (pounds)	Average Annual Landings (pounds)	Average Annual Landings as a Percentage of Total Landings in the Mid-Atlantic and New England Regions*
Spiny dogfish	Spiny Dogfish	2,168,519	1,061,854	7.9%
Summer flounder	Summer Flounder/Scup/Black Sea Bass	5,161,839	3,425,527	36.9%
Winter flounder	Northeast Multispecies (large-mesh)	947,933	357,060	9.8%
Yellowtail flounder	Northeast Multispecies (large-mesh)	1,032,864	409,308	18.8%

Source: Developed using data from NMFS (2021a, 2022b).

Notes: The table shows landings of the top 20 species landed (by pounds) in the combined Lease Area and RWEC.

* See Table 3.9-2 for Mid-Atlantic and New England fisheries data by species.

Table 3.9-7 shows the average annual revenue in the RFA by gear type from 2008 through 2019. Scallop dredge gear accounted for 34% of the revenue generated by all gear types, bottom trawl gear accounted for 30%, and clam dredge gear accounted for 14%. Table 3.9-7 also shows the percentage of each gear type's total revenue in the Mid-Atlantic and New England regions that came from the RFA from 2008 through 2019. The RFA accounted for a large share of the total revenue for clam dredge (34%), sink gillnet (32%), handline (29%), and bottom trawl (23%).

Table 3.9-7. Commercial Fishing Revenue of Federally Permitted Vessels in the Regional Fisheries Area by Gear Type (2008–2019)

Gear Type	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*
Dredge-clam	*$25,562.9*	*$20,831.9*	*34.0%*
Dredge-scallop	$105,678.5	$48,458.7	9.9%
Gillnet-sink	$13,149.3	$9,615.9	32.0%
Handline	$1,673.2	$1,369.0	28.8%
Pot-other	$19,272.8	$16,089.3	14.0%
Trawl-bottom	$60,400.9	$43,039.0	23.0%
Trawl-midwater	$5,373.1	$2,348.8	12.4%

Gear Type	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*
All other gear†	$4,061.1	$2,665.0	5.6%
Total	**$213,098.9**	**$144,417.7**	**15.1%**

Source: Developed using data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows including the Total row. Gear types shown in *italics* indicate that fewer than 12 years but more than 5 years of data were used to calculate the estimates.

* See Table 3.9-3 for Mid-Atlantic and New England fisheries data by gear type.

† Includes revenue from federally permitted vessels using longline gear, seine gear, other gillnet gear, and unspecified gear, as well as listed gear for years when they were not disclosed.

Table 3.9-8 shows the ports at which fish and shellfish caught in the RFA from 2008 through 2019 were landed. New Bedford and Point Judith together accounted for 53% of the revenue generated by commercial fishing activity in the RFA. Table 3.9-8 also shows the percentage of each port's total revenue in the Mid-Atlantic and New England regions that came from the RFA from 2008 through 2019. The RFA accounted for a large share of the total revenue for Little Compton (97%), Westport (90%), Chilmark/Menemsha (89%), Montauk (64%), Point Judith (60%), and Tiverton (57%).

Table 3.9-8. Commercial Fishing Revenue of Federally Permitted Vessels in the Regional Fisheries Area by Port (2008–2019)

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*
Beaufort, NC	*$2,031.2*	*$862.9*	*32.5%*
Chilmark/Menemsha, MA	$573.4	$419.6	89.1%
Fairhaven, MA	*$4,142.1*	*$1,439.0*	*12.8%*
Fall River, MA	*$649.8*	*$445.9*	*39.3%*
Hampton, VA	*$3,478.3*	*$1,562.6*	*10.9%*
Little Compton, RI	$2,936.8	$1,940.2	97.4%
Montauk, NY	$16,563.0	$11,859.8	64.1%
New Bedford, MA	$90,794.6	$48,503.9	12.8%
New London, CT	$5,375.6	$2,679.5	40.3%
Newport News, VA	*$3,587.3*	*$1,698.9*	*5.5%*
Newport, RI	$5,302.2	$2,880.8	32.4%
Point Judith, RI	$37,052.6	$27,546.5	59.8%
Point Pleasant Beach, NJ	*$15,019.8*	*$8,593.3*	*27.7%*

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*
Stonington, CT	$4,407.6	$3,163.5	30.8%
Tiverton, RI	*$880.0*	*$651.1*	*56.7%*
Westport, MA	$1,562.6	$1,169.0	89.6%
Revenues by Port State‡			
All Connecticut ports	$9,630.8	$5,843.0	34.4%
All Massachusetts ports	$106,063.5	$56,741.1	11.4%
All New Jersey ports	$31,706.7	$19,389.6	11.1%
All New York ports	$25,158.2	$18,262.3	56.4%
All Rhode Island ports	$42,888.3	$33,766.2	49.0%
Ports in all other states	$8,353.5	$4,325.9	3.7%
Port data withheld for confidentiality†	$9,883.2	$5,565.7	12.0%
Total	**$213,098.9**	**$144,391.8**	**15.1%**

Source: Developed using data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows, including the Total row. Ports shown in *italics* indicate that fewer than 12 years but more than 5 years of data were used to calculate the estimates.

MA = Massachusetts, MD = Maryland, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia.* See Table 3.9-4 for Mid-Atlantic and New England fisheries data by port.

‡ Revenues by Port State include all of the revenues by the ports listed above, as well as revenues of other ports within the state that were reported by NMFS, but which had 4 or fewer years of data and were not included in the table.

† Includes data for all ports that were withheld by NMFS to protect the confidentiality of individual vessels and/or buyers.

In 2010, during the first stage of the public process for BOEM's call for information and nominations to establish the WEA that would eventually become the RI/MA WEA, all of Cox Ledge was included in the area considered for leasing (i.e., call area). However, BOEM held a lengthy stakeholder and scientific review process that identified "high-value" fishing grounds and excluded those areas from the RI/MA WEA (BOEM 2012; Smythe et al. 2016). From 2008 through 2019, the excluded area accounted for approximately 22% of the revenue generated by all fisheries in the call area. It accounted for 32% of the Atlantic Sea Scallop FMP fishery revenue and 25% of the Monkfish FMP fishery revenue in the call area (NMFS 2022a). For the Atlantic Sea Scallop and Monkfish FMP fisheries combined, the revenue per square mile in the excluded area was approximately 50% higher than that in the RI/MA WEA in 2007 to 2018 (BOEM 2021a).

3.9.1.1.3 Lease Area and Revolution Wind Export Cable

The commercial fisheries that are most active in the Lease Area and along the RWEC encompass a wide range of FMP fisheries, species, gears, and landing ports (Tables 3.9-9 through 3.9-12). An overview of commercial fishing activity in the Lease Area and along the RWEC relative to that in surrounding waters was obtained from figures adapted from information available at NMFS (2020). As shown in Figures G-

CF1 through G-CF13 in Appendix G, the commercial fishing revenue for most FMP fisheries was at a low level of intensity within the Lease Area and along the RWEC compared to adjacent areas, although occasionally the revenue intensity in some localized spots inside the Lease Area was moderate for the American Lobster, Atlantic Herring, Mackerel/Squid/Butterfish, Monkfish, and Northeast Skate Complex FMP fisheries. In contrast, for some FMP fisheries, including the Monkfish, Northeast Skate Complex, and Summer Flounder/Scup/Black Sea Bass FMP fisheries, the revenue intensity levels were high in sizeable expanses of ocean outside the Lease Area and RWEC corridor but within 20 nm of the two areas.

Table 3.9-9 provides additional information on the average annual revenue in the Lease Area by FMP fishery. From 2008 through 2019, an average of 289 federally permitted commercial fishing vessels fished in the Lease Area annually, with a high of 331 vessels in 2008, and a low of 251 vessels in 2018 (NMFS 2023c). Approximately 96% of the fishing operations that engaged in commercial fishing in the Lease Area from 2019 to 2021 were small businesses, as defined by the Small Business Administration. Moreover, the fishing operations that engaged in commercial fishing in the Lease Area that are small businesses earned more of their total revenue from the area than did fishing operations that are large businesses, although for both types of businesses, the Lease Area accounted for less than 1% of their total revenue (NMFS 2023b).

On average, federally permitted commercial fishing activity in the Lease Area annually generated $1.06 million in revenue from 2008 through 2019, with the American Lobster FMP, Atlantic Sea Scallop FMP, and Monkfish FMP fisheries accounting for 20%, 14%, and 10% of the total, respectively. In terms of the percentage of each FMP fishery's total revenue in the Mid-Atlantic and New England regions that came from the Lease Area from 2008 through 2019, the area accounted for approximately 1.2% of the Northeast Skate Complex FMP fishery's total revenue and approximately 0.5% of the Monkfish FMP fishery's total revenue. In total, the Lease Area accounted for approximately 0.1% of the total revenue across all FMP and non-FMP fisheries in the Mid-Atlantic and New England regions. In terms of the percentage of each FMP fishery's total revenue in the RFA that came from the Lease Area from 2008 through 2019, the area accounted for approximately 3.8% of the Spiny Dogfish FMP fishery's total revenue, 2.7% of the American Lobster FMP fishery's total revenue, and 2.1% of the Northeast Multispecies (small-mesh) FMP fishery's total revenue. In total, the Lease Area accounted for approximately 0.7% of the total revenue across all FMP and non-FMP fisheries in the RFA. As shown in Table 3.9-9, the Monkfish, Summer Flounder/Scup/Black Sea Bass, and Northeast Skate Complex FMP fisheries accounted for the highest number of vessels fishing in the Lease Area. The average annual revenue of vessels fishing in the Lease Area was highest for vessels participating in the Atlantic Sea Scallop, Atlantic Herring, and American Lobster FMP fisheries.

Table 3.9-9. Commercial Fishing Revenue of Federally Permitted Vessels in the Lease Area by FMP Fishery (2008–2019)

FMP Fishery	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†	Average Annual Number of Vessels‡	Average Annual Revenue per Vessel
American Lobster	$364.7	$211.3	0.23%	2.71%	107	$1,972
Atlantic Herring	$144.2	$40.0	0.15%	1.34%	20	$2,009
Bluefish	$4.4	$2.2	0.17%	0.38%	115	$19
Highly Migratory Species	$6.2	$1.3	0.06%	0.60%	28	$47
Jonah Crab	$32.5	$17.8	0.19%	0.30%	51	$353
Mackerel/Squid/Butterfish	$255.0	$91.8	0.18%	0.59%	114	$802
Monkfish	$202.8	$105.0	0.51%	1.40%	157	$668
Northeast Multispecies (large-mesh)	$105.8	$45.6	0.06%	1.91%	95	$479
Northeast Multispecies (small-mesh)	$138.8	$58.6	0.52%	2.07%	97	$601
Atlantic Sea Scallop	$405.4	$148.1	0.03%	0.30%	58	$2,553
Northeast Skate Complex	$156.9	$90.2	1.21%	2.52%	123	$734
Spiny Dogfish	$22.2	$9.3	0.31%	3.81%	51	$184
Summer Flounder/Scup/Black Sea Bass	$88.5	$46.7	0.12%	0.42%	144	$324
Other FMPs, non-disclosed species, and non-FMP fisheries§	$483.8	$191.1	N/A	N/A	N/A	N/A

FMP Fishery	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†	Average Annual Number of Vessels‡	Average Annual Revenue per Vessel
Total	**$1,339.2**	**$1,059.0**	**0.11%**	**0.74%**	**289**	**N/A**

Source: Developed using data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows including the Total row. N/A indicates that the number cannot be calculated with the available data.

* See Table 3.9-1 for Mid-Atlantic and New England fisheries data by FMP fishery.

† See Table 3.9-5 for RFA fisheries data by FMP fishery.

‡ The average number of vessels that fished in the Lease Area for "All FMP and non-FMP Fisheries" was calculated based on data in NMFS (2023c).

§ The "Other FMPs, non-disclosed species, and non-FMP fisheries" category includes revenue from the Surfclam/Ocean Quahog, Red Crab, and River Herring FMP fisheries as well as revenue from other FMP fisheries managed by the ASMFC and Southeast Regional Office of NMFS. This category also includes revenue from species in FMP fisheries for which data could not be disclosed due to confidentiality restrictions.

In terms of pounds landed, the top species harvested in the Lease Area were skates (30% of the total landings in the area) and Atlantic herring (27% of the total landings in the area) (Table 3.9-10). The area accounted for approximately 1.7% of skate total landings and 1.4% of red hake total landings in the Mid-Atlantic and New England regions and approximately 4.2% of spiny dogfish total landings and 3.0% of skates, silver hake (*Merluccius bilinearis*), American lobster, red hake, and cod total landings in the RFA.

Table 3.9-10. Commercial Fishing Landings of Federally Permitted Vessels in the Lease Area by Species (2008–2019)

Species	Peak Annual Landings (pounds)	Average Annual Landings (pounds)	Average Annual Landings as a Percentage of Total Landings in the Mid-Atlantic and New England Regions*	Average Annual Landings as a Percentage of Total Landings in the RFA†
American lobster	65,969	40,356	0.21%	3.02%
Atlantic herring	1,098,682	325,365	0.21%	1.41%
Atlantic mackerel	693,500	62,883	0.33%	2.24%
Black sea bass	9,995	4,451	0.25%	1.05%
Bluefish	7,436	3,487	0.19%	0.48%
Butterfish	28,670	12,523	0.39%	1.02%
Cod	19,864	5,913	0.08%	2.93%
Jonah crab	41,670	23,907	0.20%	0.38%
Loligo squid	183,469	57,410	0.23%	0.56%
Monkfish	132,153	68,060	0.70%	1.58%
Red hake	47,244	19,245	1.42%	2.92%
Rock crab	10,061	3,830	0.41%	0.57%
Scup	81,771	45,075	0.42%	0.63%
Sea scallop	48,945	14,997	0.03%	0.32%
Silver hake	252,313	94,308	0.67%	2.65%
Skates	681,186	358,490	1.68%	2.57%
Spiny dogfish	95,550	44,507	0.33%	4.19%
Summer flounder	31,011	13,533	0.15%	0.40%
Winter flounder	11,334	4,898	0.13%	1.37%
Yellowtail flounder	28,513	6,920	0.32%	1.69%

Source: Developed using data from NMFS (2021a, 2022b).

Notes: The table shows landings of the top 20 species landed (by pounds) in the combined Lease Area and RWEC.

* See Table 3.9-2 for Mid-Atlantic and New England fisheries data by species.

† See Table 3.9-6 for RFA fisheries data by species.

Data provided in NMFS (2021b) were used to analyze differences in the economic importance of fishing grounds in the Lease Area across commercial fishing operations. These data summarize the number of federally permitted commercial fishing vessels fishing in the Lease Area each year from 2008 through 2019, as well as the percentage of each vessel's annual total fishing revenue that came from within the area. The complete analysis of differences in economic dependency on the Lease Area across vessels is provided in Appendix G. As shown in the appendix, the vessel-level annual revenue percentages were divided into quartiles, which were created by ordering the data from the lowest to highest percentage and then dividing the data into four groups of equal size. The first quartile represents the lowest 25% of ranked percentages, whereas the fourth quartile represents the highest 25%. In addition, the data provided in NMFS (2023c) reported the number of "outlier" vessels in the distribution of the percentage of revenue. In the context of this analysis, an outlier is a vessel that derived an exceptionally high proportion of its annual revenue from the Lease Area in comparison to other vessels that fished in the area.

As discussed above, an average of 289 vessels per year fished in the Lease Area from 2008 through 2019. The average annual number of outliers was 40.5 (14% of all vessels), with a high of 47 outliers in 2016 (14.6% of all vessels) and a low of 31 outliers in 2011 (12% of all vessels). From 2008 through 2019, the vessel ranked as the seventy-fifth percentile vessel (i.e., the vessel in the third quartile with the greatest dependence on the Lease Area over the 12-year period) derived 0.88% of its total revenue from the Lease Area (NMFS 2021b). Of the outliers, the vessel with the greatest dependence on the Lease Area derived 38% of its total revenue over the 12-year period from the area. Looking at individual years shown in Figure G-CF14 in Appendix G, in 2008, one vessel derived nearly 60% of its total revenue from the Lease Area. In that same year, the vessel with the greatest percentage of dependence in the third quartile generated approximately 2.2% of its revenue from the Lease Area. Figure G-CF14 shows that in any given year the revenue percentage for most of the outliers was below 10%. In short, some vessels depended heavily on the Lease Area, but most vessels derived a small percentage of their total annual revenue from the area.

Table 3.9-11 provides the average annual revenue in the Lease Area by gear type from 2008 through 2019. Together, scallop dredge, sink gillnet, bottom trawl, and pot gear accounted for approximately 79% of the total revenue generated by all gear types in the Lease Area. The area accounted for approximately 0.6% of the sink gillnet gear's total revenue in the Mid-Atlantic and New England regions, and approximately 1.8% of that gear's total revenue in the RFA. Approximately 1.9% of the midwater trawl gear's total revenue in the RFA came from the area.

Table 3.9-11. Commercial Fishing Revenue of Federally Permitted Vessels in the Lease Area by Gear Type (2008–2019)

Gear Type	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†
Dredge-clam	*$372.3*	*$111.7*	*0.18%*	*0.54%*
Dredge-scallop	$412.1	$148.7	0.03%	0.31%
Gillnet-sink	$253.3	$169.3	0.56%	1.76%
Handline	$14.6	$2.7	0.06%	0.19%
Pot-other	$389.9	$258.8	0.22%	1.61%

Gear Type	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†
Trawl-bottom	$467.3	$314.7	0.17%	0.73%
Trawl-midwater	*$132.8*	*$43.6*	*0.23%*	*1.86%*
All other gear‡	$268.7	$79.3	0.17%	2.98%
Total	**$1,339.2**	**$1,128.8**	**0.12%**	**0.78%**

Source: Developed using data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows, including the Total row. Gear types shown in *italics* indicate that fewer than 12 years but more than 5 years of data were used to calculate the estimates. Otherwise, estimates are based on 12 years of data

* See Table 3.9-3 for Mid-Atlantic and New England fisheries data by gear type.

† See Table 3.9-7 for RFA fisheries data by gear type.

‡ Includes revenue from federally permitted vessels using longline gear, seine gear, other gillnet gear, and unspecified gear, as well as listed gear, for years when they cannot be disclosed.

Table 3.9-12 shows the ports at which fish and shellfish caught in the Lease Area from 2008 through 2019 were landed. Together, Point Judith, New Bedford, and Little Compton accounted for approximately 79% of the revenue generated by commercial fishing activity in the Lease Area. Little Compton and Westport were the ports most dependent on the Lease Area, with 5.7% and 4.6%, respectively, of their total commercial fishing revenue in the Mid-Atlantic and New England regions derived from the Lease Area, and with 5.9% and 5.2%, respectively, of their total commercial fishing revenue in the RFA derived from the Lease Area.

Table 3.9-12. Commercial Fishing Revenue of Federally Permitted Vessels in the Lease Area by Port (2008–2019)

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†
Beaufort, NC	$4.6	$2.3	0.09%	0.26%
Chilmark/Menemsha, MA	$28.2	$16.7	3.55%	3.98%
Fairhaven, MA	$28.1	$14.9	0.13%	1.03%
Fall River, MA	$8.3	$5.4	0.48%	1.21%
Hampton, VA	$7.3	$3.4	0.02%	0.22%
Little Compton, RI	$169.3	$115.0	5.77%	5.93%
Montauk, NY	$37.1	$16.2	0.09%	0.14%
New Bedford, MA	$530.5	$326.5	0.09%	0.67%
New London, CT	$18.9	$8.6	0.13%	0.32%
Newport News, VA	$14.7	$3.7	0.01%	0.22%

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†
Newport, RI	$105.7	$58.7	0.66%	2.04%
Point Judith, RI	$510.2	$379.1	0.82%	1.38%
Point Pleasant Beach, NJ	$14.4	$4.0	0.01%	0.05%
Stonington, CT	$18.5	$6.5	0.06%	0.21%
Tiverton, RI	$16.7	$7.1	0.61%	1.08%
Westport, MA	$111.6	$60.6	4.64%	5.18%
Revenues by Port State‡				
All Connecticut ports	$37.4	$11.5	0.07%	0.20%
All Massachusetts ports	$621.9	$421.5	0.08%	0.74%
All New Jersey ports	*$14.4*	*$4.2*	*0.00%*	*0.02%*
All New York ports	$37.1	$16.2	0.05%	0.09%
All Rhode Island ports	$715.8	$559.1	0.81%	1.66%
Ports in all other states	*$22.0*	*$7.3*	*0.01%*	*0.17%*
Port data withheld for confidentiality‡	$98.8	$43.8	0.09%	0.79%
Total	$1,339.2	$1,063.6	0.11%	0.74%

Source: Developed using data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Ports shown in *italics* indicate that fewer than 12 years more than 4 years of data were used to calculate the estimates of average revenue. Otherwise, estimates are based on 12 years of data.

MA = Massachusetts, MD = Maryland, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia.

* See Table 3.9-4 for Mid-Atlantic and New England fisheries data by port.

† See Table 3.9-8 for RFA fisheries data by port.

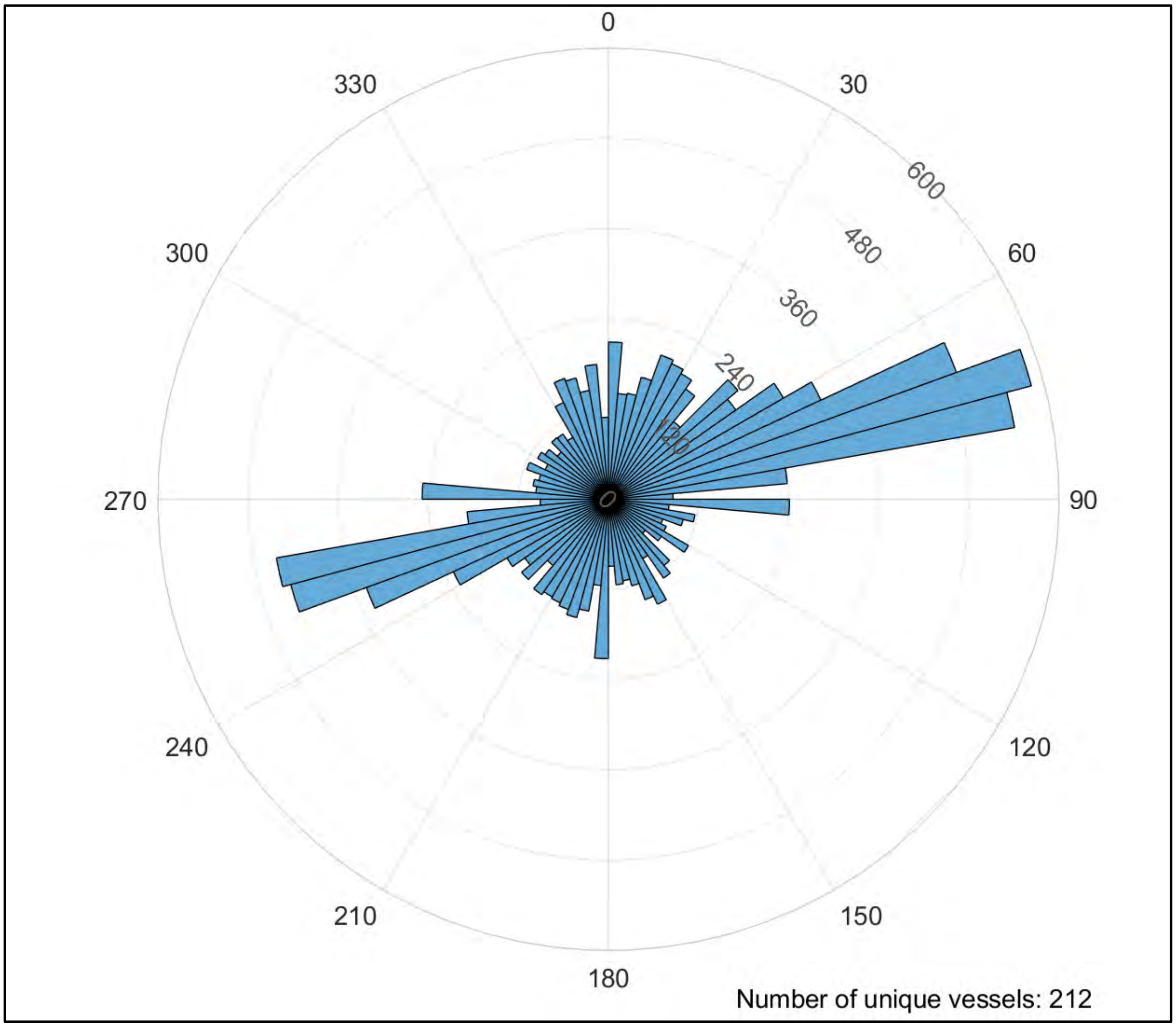
‡ Revenues by Port State include all of the revenues by the ports listed above, as well as revenues of other ports within the state that were reported by NMFS, but which had 4 or fewer years of data and were not included in the table.

‡ Includes data for all ports that were withheld by NMFS to protect the confidentiality of individual vessels and/or buyers.

The NMFS VMS data are a good source for understanding the spatial distribution of fishing vessels in the Lease Area. As discussed in Appendix G, from 2014 to 2019, vessels with VMS accounted for a substantial portion (90% or greater) of landings in several federally permitted fisheries in the Mid-Atlantic and New England regions, including the Atlantic Sea Scallop, Monkfish, Atlantic Herring, Mackerel/Squid/Butterfish, Northeast Multispecies (large- and small-mesh), Spiny Dogfish, Summer Flounder/Scup/Black Sea Bass, and Surfclam/Ocean Quahog FMP fisheries. VMS-enabled vessels represented approximately 11% of landings in the American Lobster and 14 % in the Jonah Crab FMP fisheries (NMFS 2019).

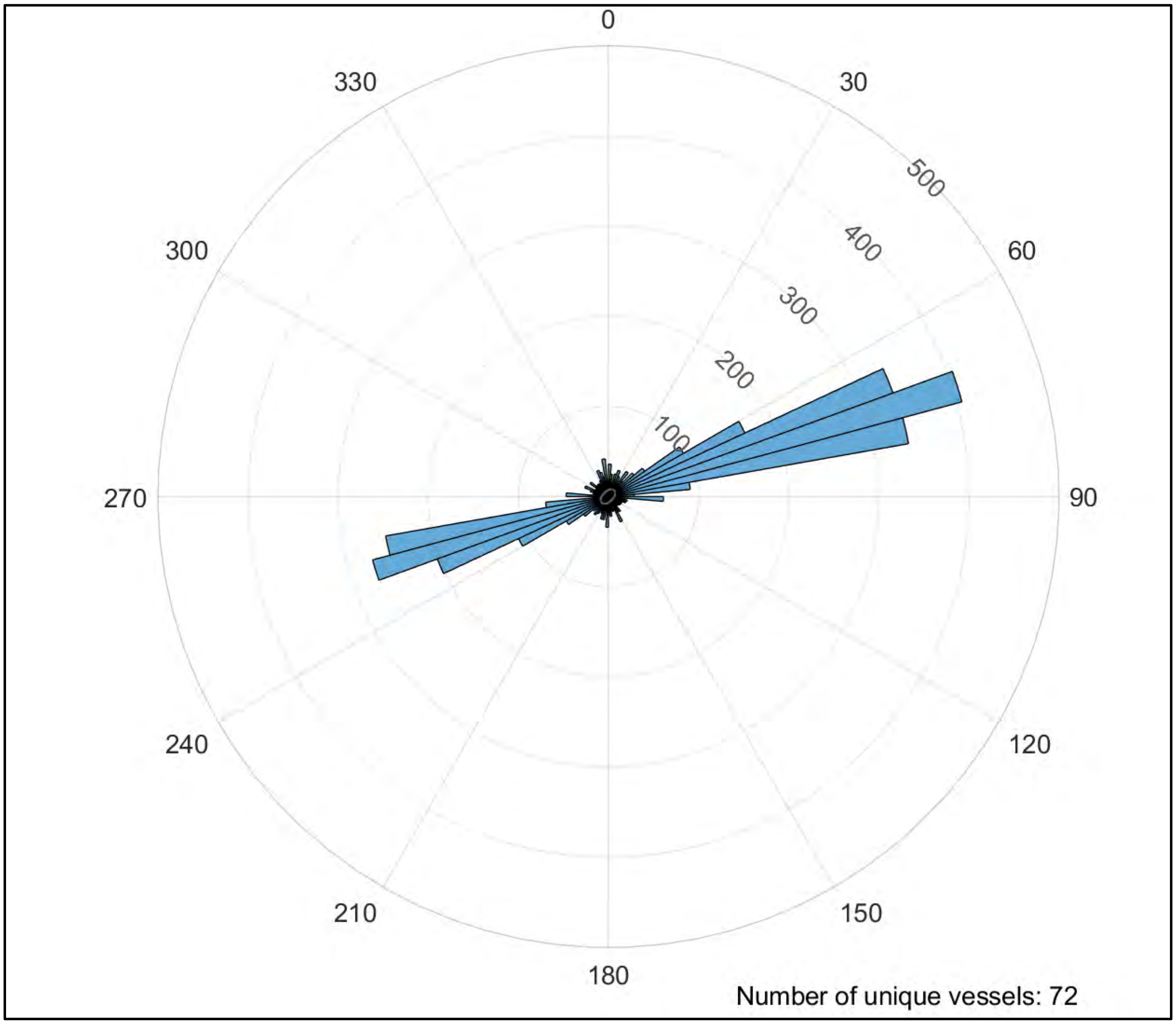
Based on data provided by NMFS (2019), polar histograms (Figure 3.9-3 through Figure 3.9-6) showing the directionality of VMS-enabled vessels fishing in the Lease Area were developed using the information conveyed in individual position reports (pings) from January 2014 to August 2019. Vessels moving at speeds less than 5 knots were assumed to be actively fishing. The larger bars in the polar histograms represent a greater number of position reports showing fishing vessels moving in a certain direction within the RI/MA WEA. The polar histograms differ with respect to their scales.

Figure 3.9-3 shows that most of the 212 unique vessels participating in FMP fisheries in the Lease Area followed a northeast–southwest fishing pattern. As shown in Figure 3.9-4, most of the 72 unique vessels participating in non-VMS fisheries in the Lease Area followed a similar fishing pattern. Figure 3.9-5 shows that the orientation of vessels fishing within the Lease Area varied by FMP fishery. Figure 3.9-6 shows the directionality of all activities (transiting and fishing combined) in the Lease Area. Most of the 488 unique vessels participating in a VMS fishery generally operated in a southwest–northeast pattern with a secondary pattern of northwest–southeast.



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

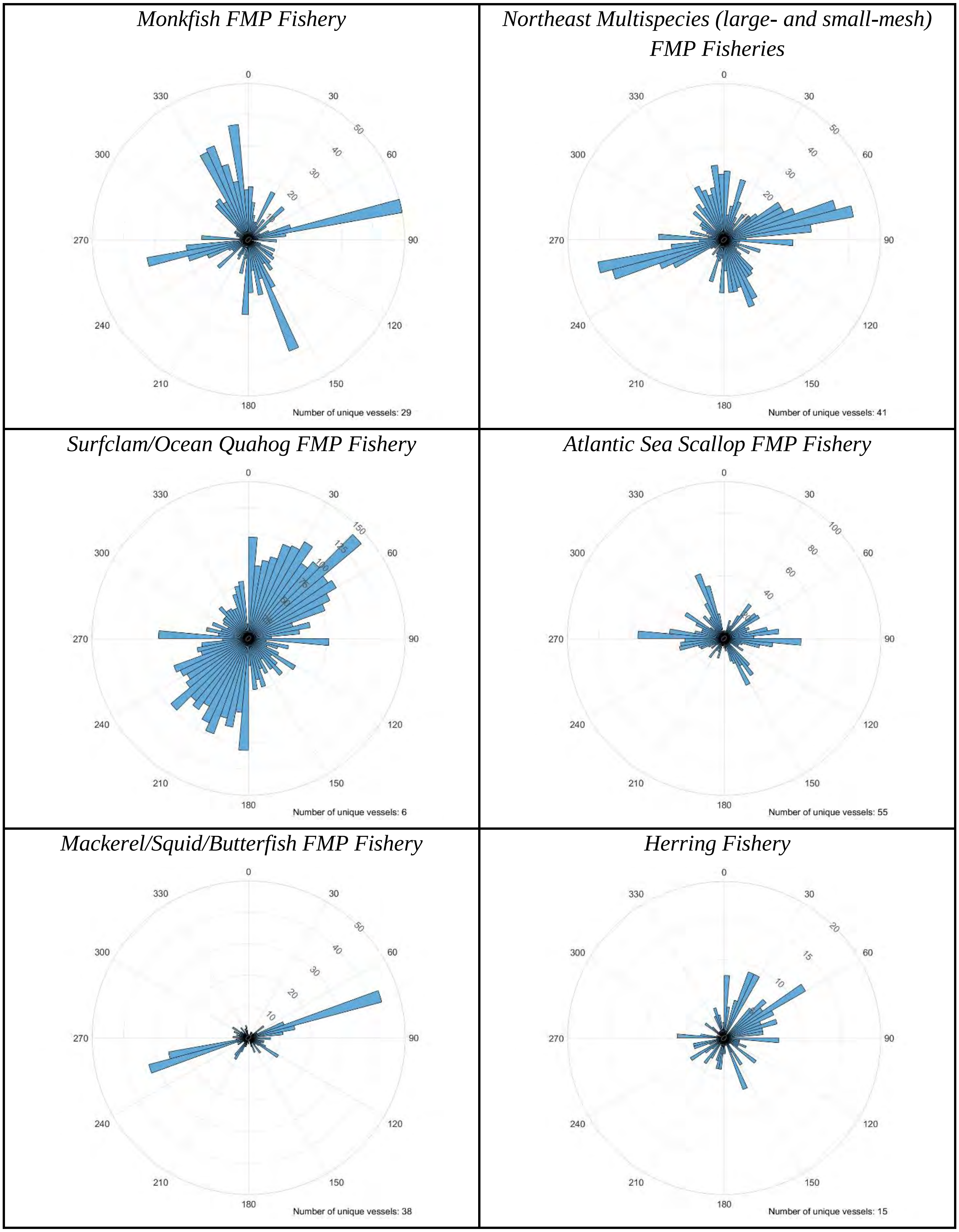
Figure 3.9-3. Vessel monitoring system bearings of vessels actively fishing within the Lease Area, all FMP fisheries combined, January 2014 to August 2019.



Notes: These are fishing vessels that are transmitting VMS data after having declared themselves as participating in a fishery that does not require VMS transmissions.

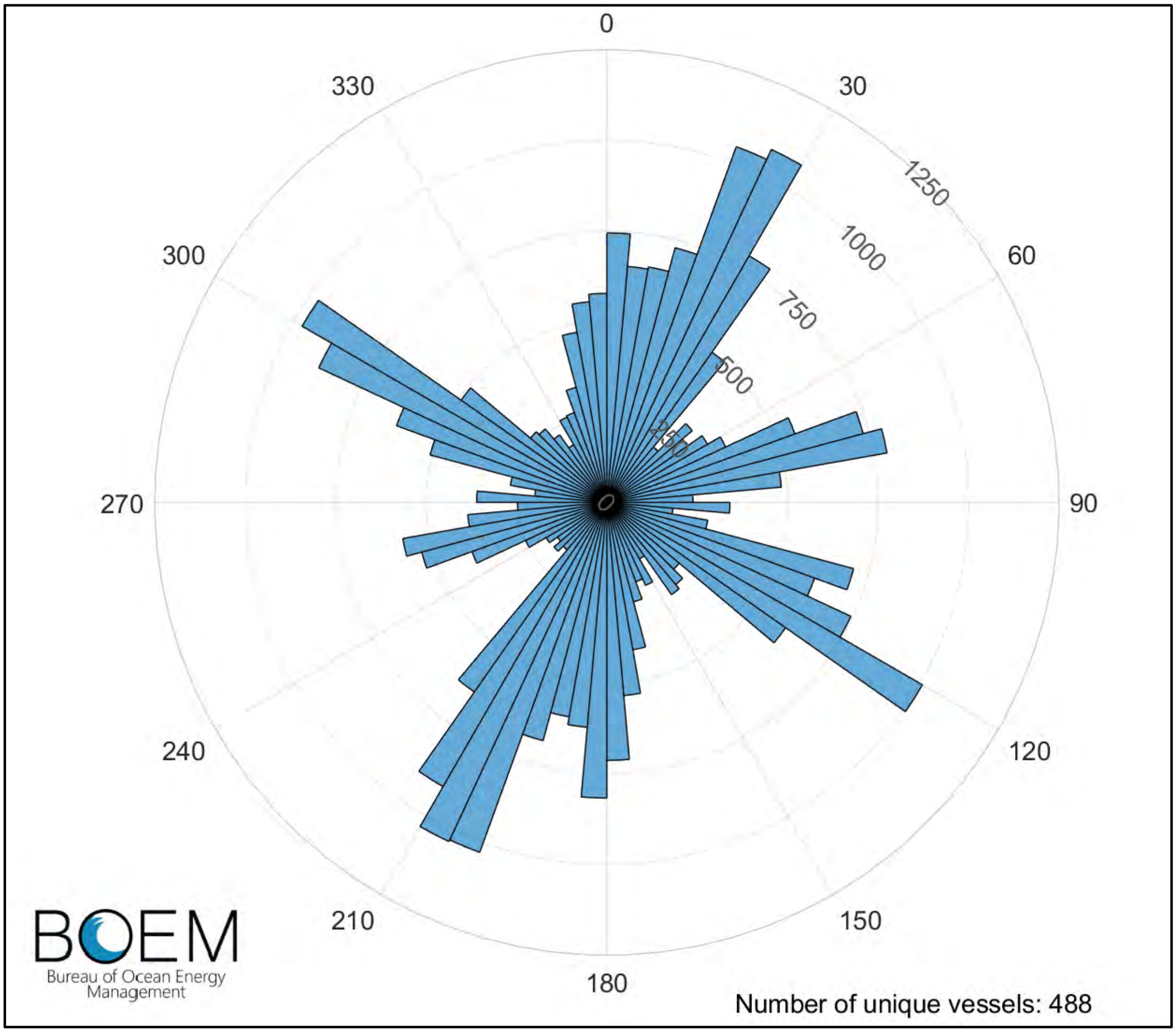
Source: Developed by BOEM using VMS data provided by NMFS (2019).

Figure 3.9-4. Vessel monitoring system bearings of vessels actively fishing within the Lease Area, non–vessel monitoring system fisheries, January 2014 to August 2019.



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

Figure 3.9-5. Vessel monitoring system bearings of vessels actively fishing within the Lease Area by FMP fishery, January 2014 to August 2019.



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

Figure 3.9-6. Vessel monitoring system bearings for all activity within the Lease Area, January 2014 to August 2019.

Table 3.9-13 presents the average annual revenue in the corridor along the RWEC by FMP fishery from 2008 through 2019. On average, federally permitted commercial fishing activity along the RWEC annually generated $359.7 thousand in revenue, with the American Lobster FMP fishery, Atlantic Herring FMP fishery, and Mackerel/Squid/Butterfish FMP fishery accounting for 20%, 17%, and 15% of the total revenue, respectively. In terms of the percentage of each FMP fishery's total revenue in the Mid-Atlantic and New England regions that came from the RWEC corridor from 2008 through 2019, the area accounted for approximately 0.5% of the Bluefish FMP fishery's total revenue, 0.3% of the Northeast Skate Complex FMP fishery's total revenue, and 0.2% of the Atlantic Herring FMP fishery's and Spiny Dogfish FMP fishery's total revenue. In total, the RWEC corridor accounted for approximately 0.04% of the total revenue across all FMP and non-FMP fisheries in the Mid-Atlantic and New England regions. In terms of the percentage of each FMP fishery's total revenue in the RFA that came from the RWEC corridor from 2008 through 2019, the area accounted for approximately 2.6% of the Spiny Dogfish FMP fishery's total revenue, 2.1% of the Atlantic Herring FMP fishery's total revenue, and 1.1% of the Bluefish FMP fishery's total revenue. In total, the RWEC corridor accounted for approximately 0.25% of the total revenue across all FMP and non-FMP fisheries in the RFA.

Table 3.9-13. Commercial Fishing Revenue of Federally Permitted Vessels along the Revolution Wind Export Cable by FMP Fishery (2008–2019)

FMP Fishery	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†
American Lobster	$143.1	$72.5	0.08%	0.93%
Atlantic Herring	$179.5	$62.9	0.24%	2.10%
Bluefish	$12.8	$6.5	0.51%	1.12%
Highly Migratory Species	$1.8	$0.9	0.04%	0.40%
Jonah Crab	$9.9	$5.3	0.06%	0.09%
Mackerel/Squid/Butterfish	$112.3	$53.5	0.10%	0.35%
Monkfish	$8.6	$4.9	0.02%	0.07%
Northeast Multispecies (large-mesh)	$11.7	$6.9	0.01%	0.29%
Northeast Multispecies (small-mesh)	$54.4	$15.7	0.14%	0.56%
Atlantic Sea Scallop	$20.7	$9.0	0.00%	0.02%
Northeast Skate Complex	$46.1	$20.6	0.28%	0.57%
Spiny Dogfish	$16.0	$6.4	0.22%	2.64%
Summer Flounder/Scup/Black Sea Bass	$48.0	$37.5	0.09%	0.34%
Other FMPs, non-disclosed species, and non-FMP fisheries‡	$101.9	$56.9	N/A	N/A
Total	**$519.7**	**$359.7**	**0.04%**	**0.25%**

Source: Developed using data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows including the Total row.

* See Table 3.9-1 for Mid-Atlantic and New England fisheries data by FMP fishery.

† See Table 3.9-5 for RFA fisheries data by FMP fishery.

‡ The "Other FMPs, non-disclosed species, and non-FMP fisheries" category includes revenue from three FMP fisheries: Surfclam/Ocean Quahog, Red Crab, and River Herring. It also includes a) revenue from species in FMP fisheries for which data could not be disclosed due to confidentiality restrictions and b) revenue earned by federally permitted vessels operating in fisheries that are not federally managed.

In terms of pounds landed, the top species harvested along the RWEC were Atlantic herring (60% of the total landings in the area) and skates (15% of the total landings in the area (Table 3.9-14). The area along the RWEC accounted for approximately 0.59% of skates total landings and 0.44% of scup total landings in the Mid-Atlantic and New England regions, and approximately 2.3% of spiny dogfish and Atlantic herring total landings in the RFA.

Table 3.9-14. Commercial Fishing Landings of Federally Permitted Vessels along the Revolution Wind Export Cable by Species (2008–2019)

Species	FMP	Peak Annual Landings (pounds)	Average Annual Landings (pounds)	Average Annual Landings as a Percentage of Total Landings in the Mid-Atlantic and New England Regions*	Average Annual Landings as a Percentage of Total Landings in the RFA†
American lobster	American Lobster	25,780	13,779	0.07%	1.03%
Atlantic herring	Atlantic Herring	1,773,535	519,326	0.33%	2.25%
Atlantic mackerel	Mackerel/Squid/Butterfish	151,724	20,483	0.11%	0.73%
Black sea bass	Summer Flounder/Scup/Black Sea Bass	2,997	2,036	0.11%	0.48%
Bluefish	Bluefish	18,315	9,243	0.51%	1.27%
Butterfish	Mackerel/Squid/Butterfish	24,319	10,998	0.34%	0.89%
Cod	Northeast Multispecies (large-mesh)	1,240	617	0.01%	0.31%
Jonah crab	Jonah Crab	12,348	7,438	0.06%	0.12%
Loligo squid	Mackerel/Squid/Butterfish	85,935	31,217	0.13%	0.31%
Monkfish	Monkfish	5,440	2,902	0.03%	0.07%
Red hake	Northeast Multispecies (small-mesh)	10,185	4,860	0.36%	0.74%
Rock crab	Other FMPs, non-disclosed species and non-FMP fisheries	3,428	2,141	0.23%	0.32%
Scup	Summer Flounder/Scup/Black Sea Bass	94,284	47,550	0.44%	0.67%
Sea scallop	Atlantic Sea Scallop	1,712	848	0.00%	0.02%

Species	FMP	Peak Annual Landings (pounds)	Average Annual Landings (pounds)	Average Annual Landings as a Percentage of Total Landings in the Mid-Atlantic and New England Regions*	Average Annual Landings as a Percentage of Total Landings in the RFA†
Silver hake	Northeast Multispecies (small-mesh)	97,186	25,993	0.18%	0.73%
Skates	Northeast Skate Complex	239,722	125,479	0.59%	0.90%
Spiny dogfish	Spiny Dogfish	62,007	24,793	0.19%	2.33%
Summer flounder	Summer Flounder/Scup/Black Sea Bass	14,798	10,002	0.11%	0.29%
Winter flounder	Northeast Multispecies (large-mesh)	3,556	1,467	0.04%	0.41%
Yellowtail flounder	Northeast Multispecies (large-mesh)	1,898	678	0.03%	0.17%

Source: Developed using data from NMFS (2021a, 2022b).

Notes: The table shows landings of the top 20 species landed (by pounds) in the combined Lease Area and RWEC.

* See Table 3.9-2 for Mid-Atlantic and New England fisheries data by species.

† See Table 3.9-6 for RFA fisheries data by species.

Table 3.9-15 provides the average annual revenue along the RWEC area by gear type from 2008 through 2019. Together, pot gear, bottom trawl, and midwater trawl gear accounted for approximately 86% of the revenue generated by commercial fishing activity along the RWEC area. The area accounted for about 0.29% of midwater trawl gear total revenue in the Mid-Atlantic and New England regions. The area accounted for about 2.32% of midwater trawl total revenue in the RFA.

Table 3.9-15. Commercial Fishing Revenue of Federally Permitted Vessels along the Revolution Wind Export Cable by Gear Type (2008–2019)

Gear Type	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†
Dredge-clam	ND	ND	ND	ND
Dredge-scallop	$20.6	$9.8	0.00%	0.02%
Gillnet-sink	$49.3	$28.1	0.09%	0.29%
Handline	$1.7	$1.1	0.02%	0.08%
Pot-other	$141.3	$86.6	0.08%	0.54%
Trawl-bottom	$263.6	$177.4	0.09%	0.41%
Trawl-midwater	*$131.8*	*$54.5*	*0.29%*	*2.32%*
All other gear‡	$27.6	$12.2	0.03%	0.46%
Total	**$519.7**	**$369.6**	**0.04%**	**0.26%**

Source: Developed using data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Gear types shown in *italics* indicate that fewer than 12 years but more than 4 years of data were used to calculate the estimates. Otherwise, estimates are based on 12 years of data. Vessels with 4 or fewer years of reported data are shown with an ND (non-disclosed) for average revenues and for percentages of other areas.

* See Table 3.9-3 for Mid-Atlantic and New England fisheries data by gear type.

† See Table 3.9-7 for RFA fisheries data by gear type.

‡ Includes revenue from federally permitted vessels using longline gear, seine gear, other gillnet gear, and unspecified gear, as well as listed gear for years when they were not disclosed.

Table 3.9-16 shows the ports where fish and shellfish caught along the RWEC from 2008 through 2019 were landed. Together, Point Judith, New Bedford, and Newport accounted for approximately 83% of the revenue generated by commercial fishing activity within the RWEC corridor. In terms of total commercial fishing revenue in the Mid-Atlantic and New England regions, Little Compton was the port most dependent on the RWEC corridor, with 1.4% of its revenue derived from the area. In terms of total commercial fishing revenue in the RFA, Newport was the port most dependent on the RWEC corridor, with 1.7% of its revenue derived from the area.

Table 3.9-16. Commercial Fishing Revenue of Federally Permitted Vessels along the Revolution Wind Export Cable by Port (2008–2019)

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†
Beaufort, NC	*$0.8*	*$0.5*	*0.02%*	*0.05%*
Chilmark/Menemsha, MA	*$0.9*	*$0.4*	*0.09%*	*0.10%*
Fairhaven, MA	*$1.7*	*$0.9*	*0.01%*	*0.07%*
Fall River, MA	*$11.0*	*$4.8*	*0.43%*	*1.09%*
Hampton, VA	*$1.2*	*$0.6*	*0.00%*	*0.04%*
Little Compton, RI	$53.0	$28.2	1.42%	1.45%
Montauk, NY	$6.1	$2.6	0.01%	0.02%
New Bedford, MA	$111.0	$42.9	0.01%	0.09%
New London, CT	*$4.9*	*$1.8*	*0.03%*	*0.07%*
Newport News, VA	*$1.5*	*$0.4*	*0.00%*	*0.02%*
Newport, RI	$88.4	$50.2	0.56%	1.74%
Point Judith, RI	$260.6	$195.1	0.42%	0.71%
Point Pleasant Beach, NJ	*$2.3*	*$0.7*	*0.00%*	*0.01%*
Stonington, CT	$3.0	$1.1	0.01%	0.03%
Tiverton, RI	*$1.9*	*$1.0*	*0.08%*	*0.15%*
Westport, MA	$12.8	$6.6	0.50%	0.56%
Revenues by Port State‡				
All Connecticut Ports	$6.9	$2.1	0.01%	0.04%
All Massachusetts Ports	$116.8	$52.8	0.01%	0.09%
All New Jersey Ports	*$12.8*	*$2.5*	*0.00%*	*0.01%*
All New York Ports	$6.1	$2.6	0.01%	0.01%
All Rhode Island Ports	$380.6	$274.8	0.40%	0.81%
Ports in all other states	*$2.3*	*$1.1*	*0.00%*	*0.02%*
Port data withheld for confidentiality‡	$46.9	$25.0	0.05%	0.45%

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions*	Average Annual Revenue as a Percentage of Total Revenue in the RFA†
Total	**$519.7**	**$360.9**	**0.04%**	**0.25%**

Source: Developed using data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Ports shown in *italics* indicate that fewer than 12 years but more than 4 years of data were used to calculate the estimates. Otherwise, estimates are based on 12 years of data. Vessels with 4 or fewer years of reported data are shown with an ND for average revenues and for percentages of other areas.

MA = Massachusetts, MD = Maryland, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia.

* See Table 3.9-4 for Mid-Atlantic and New England fisheries data by port.

† See Table 3.9-8 for RFA fisheries data by port.

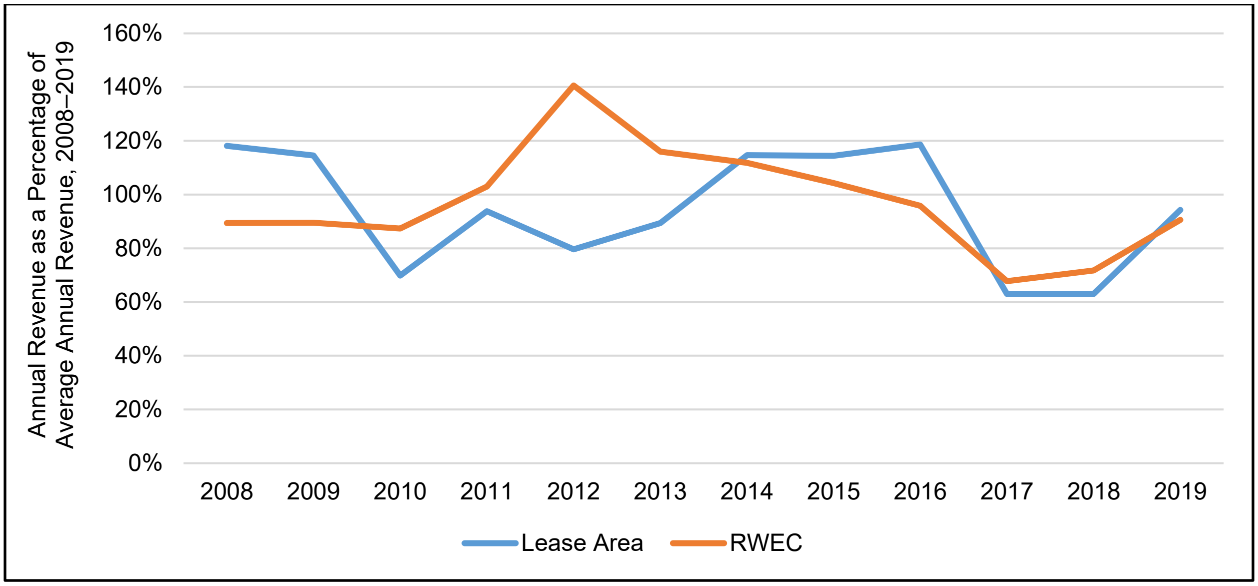
‡ Revenues by Port State include all of the revenues by the ports listed above, as well as revenues of other ports within the state that were reported by NMFS, but which had 4 or fewer years of data and were not included in the table.

‡ Includes data for all ports that were withheld by NMFS to protect the confidentiality of individual vessels and/or buyers.

A large portion of the RWEC corridor would be located in Rhode Island state waters. As discussed above, the landings of fishing vessels with only state permits are not included in the federal VTR dataset. In addition, state VTR data are unavailable for fishing activity occurring specifically in the portion of the proposed RWEC corridor located in state waters. However, state VTR data are available for Rhode Island –only permitted vessels that fished in Greater Atlantic Region Statistical Area 539, which is the statistical area most relevant to the RWEC (Figure 3.9-2). Tables summarizing the landings of these vessels from 2009 through 2018 are shown in Appendix G, Tables G-CF3 through G-CF5. Landings are reported by species, gear type, and port of landing.

As shown in Table G-CF3, from 2009 to 2018, commercial fishermen permitted to fish in Rhode Island state waters landed many different species in Statistical Area 539, including in order of highest average annual landings by weight, scup (*Stenotomus chrysops*) (781,887 pounds), channeled whelk (*Busycotypus canaliculatus*) (355,805 pounds), summer flounder (223,629 pounds), menhaden (*Brevoortia tyrannus*) (200,245 pounds), skates (120,571 pounds), and striped bass (*Morone saxatilis*) (119,233 pounds). Top gear type categories by landings were pots and traps (746,812 pounds), other fixed nets (432,516 pounds), hook and line (388,116 pounds), and otter trawls (259,353 pounds) (see Table G-CF4). The top ports where fishermen landed their catch from fishing in Rhode Island state waters in Statistical Area 539 were Point Judith, Little Compton, Newport, Bristol, and North Kingstown (see Table G-CF5). Point Judith was the port with the highest average annual landings (672,982 pounds) in Statistical Area 539 and the largest number of fishing permits making landings in the area (459 permits).

Figure 3.9-7 summarizes the inter-annual variability of revenues within the Lease Area and the RWEC. Annual revenue in the Lease Area varies between 119% and 63% of the average from 2008 to 2019. Annual revenue within the RWEC varies between 141% and 68% of the average.



Source: Developed using data from NMFS (2022b).

Figure 3.9-7. Interannual variability of commercial fishing revenue of federally permitted vessels in the Lease Area and along the Revolution Wind Export Cable, 2008–2019.

3.9.1.2 For-Hire Recreational Fishing

For-hire recreational fishing boats are operated by licensed captains for businesses that sell recreational fishing trips to anglers. These boats include both party (head) boats, which are defined as boats on which fishing space and privileges are provided for a fee, and charter boats, defined as boats operating under charter for a price, time, etc., and the participants are part of a preformed group of anglers (NMFS 2021e).

The following analysis focuses on for-hire recreational fishing activity in the Lease Area. The primary source of party and charter boat catch and effort data in the area was VTR data provided by NMFS (2023d).[26] To understand the relative importance of the Lease Area to federally permitted party and charter boats the analysis compares the vessel trips, and angler trips reported in the Lease Area to the total for-hire recreational fishing catch and effort across the Mid-Atlantic and New England Regions. In addition, to provide a more localized geographical context, the analysis describes the for-hire recreational fishing activity occurring in and around the RI/MA WEA. This description includes a discussion of the area of high value fisheries that was excluded by BOEM from possible leasing for wind energy development in order to reduce conflict with both commercial and recreational fishing activities.

As with the commercial fisheries analysis, the analysis for for-hire recreational fishing predominantly uses fisheries data for the 2008–2019 period.

3.9.1.2.1 Regional Fisheries Area

A comprehensive list of species that are targeted by for-hire boats within the study area of the *Rhode Island Ocean Special Management Plan* was developed through an iterative process using catch data and correspondence with recreational charter boat captains (RI CRMC 2010). This study area encompasses a

[26] NMFS requires all federally permitted party and charter boats to submit a VTR for every fishing trip (50 CFR 648.7).

broad region in and around the RI/MA WEA, including portions of Block Island Sound, Rhode Island Sound, and the Atlantic Ocean. As shown in Table 3.9-17, for-hire boats target a wide range of pelagic and demersal species.

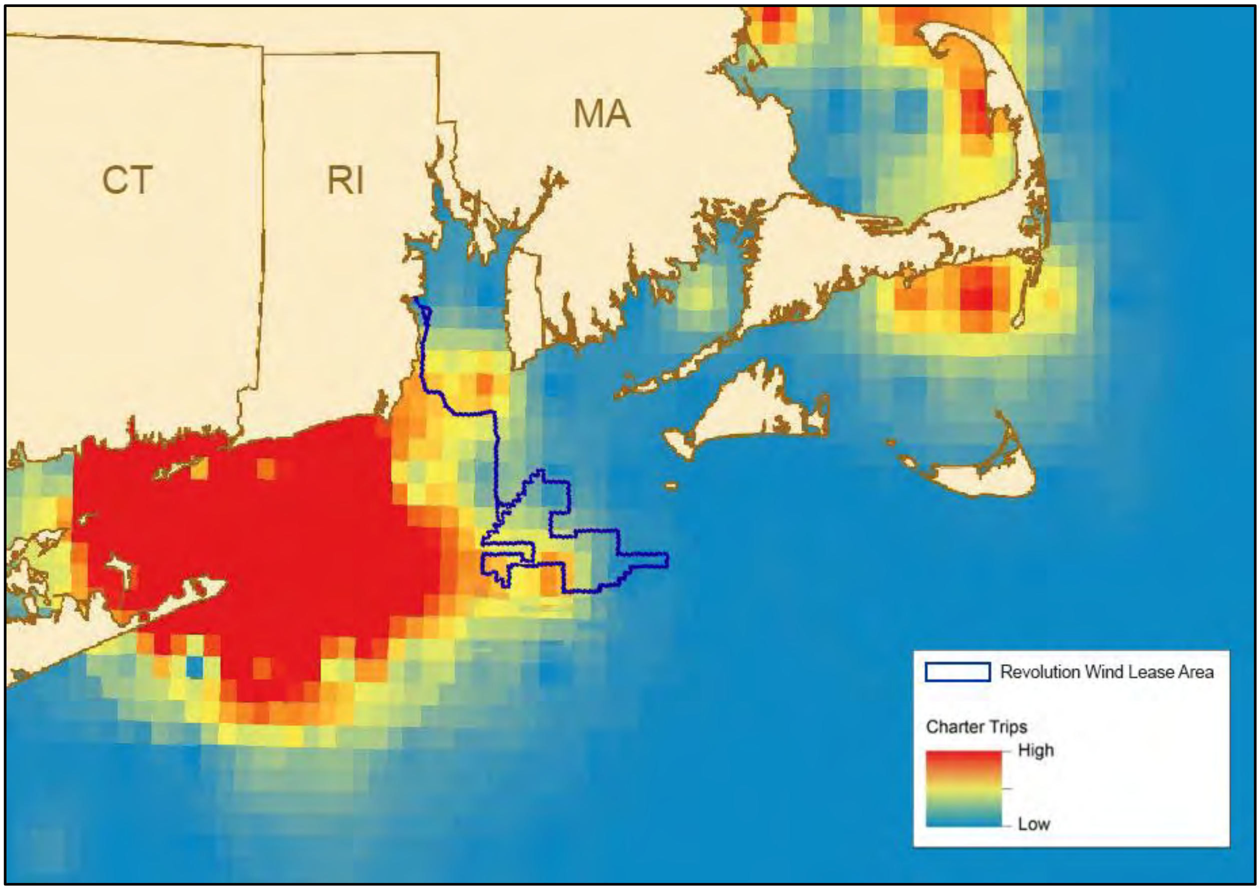
Table 3.9-17. Species Targeted by For-Hire Recreational Fishing Boats in the Rhode Island Ocean Special Management Plan Area

Atlantic bonito	Bluefin tuna	Scup	Tautog
Atlantic cod	Bluefish	Shortfin mako	Thresher shark
Black sea bass	False albacore	Striped bass	Winter flounder
Blue shark	Pollock	Summer flounder	Yellowfin tuna

Source: RI CRMC (2010).

Recreational fishing in the region occurs year-round but is most intensive from April through November (Tetra Tech 2016). Early in spring, most of the Rhode Island–based party and charter boats target the migratory stocks of the Mid-Atlantic and New England regions such as striped bass, summer flounder, and black sea bass (*Centropristis striata*). During late spring, party and charter boats almost exclusively target cod, with most of the cod fishing occurring on Cox Ledge and south of Block Island (RI CRMC 2010). Cod fishing on Cox Ledge is also popular in the summer as the water warms and cod start to congregate on the ledge (Plaia 2009). However, most summer recreational fishing is focused on striped bass and bluefish, with some boats targeting summer flounder closer to shore. Later in the summer, some of the boats move farther offshore to target sharks, which are generally caught anywhere from 20 to 50 miles offshore. Sharks targeted include blue, mako, and thresher sharks, with most shark fishing being catch and release. Some tuna fishing also takes place in an area east of Block Island and northwest of Cox Ledge known as the Mud Hole or Deep Hole. Starting in September, much of the fishing switches to sea bass and scup around Block Island or to striped bass closer to shore (RI CRMC 2010). Many recreational fishermen participate in organized sportfishing tournaments during the year. For example, the Rhode Island Saltwater Anglers Association sponsors 15 tournaments per year and a “Yearlong Tournament” targeting the majority of recreational species in the *Rhode Island Ocean Special Management Plan Area* (RI CRMC 2010).

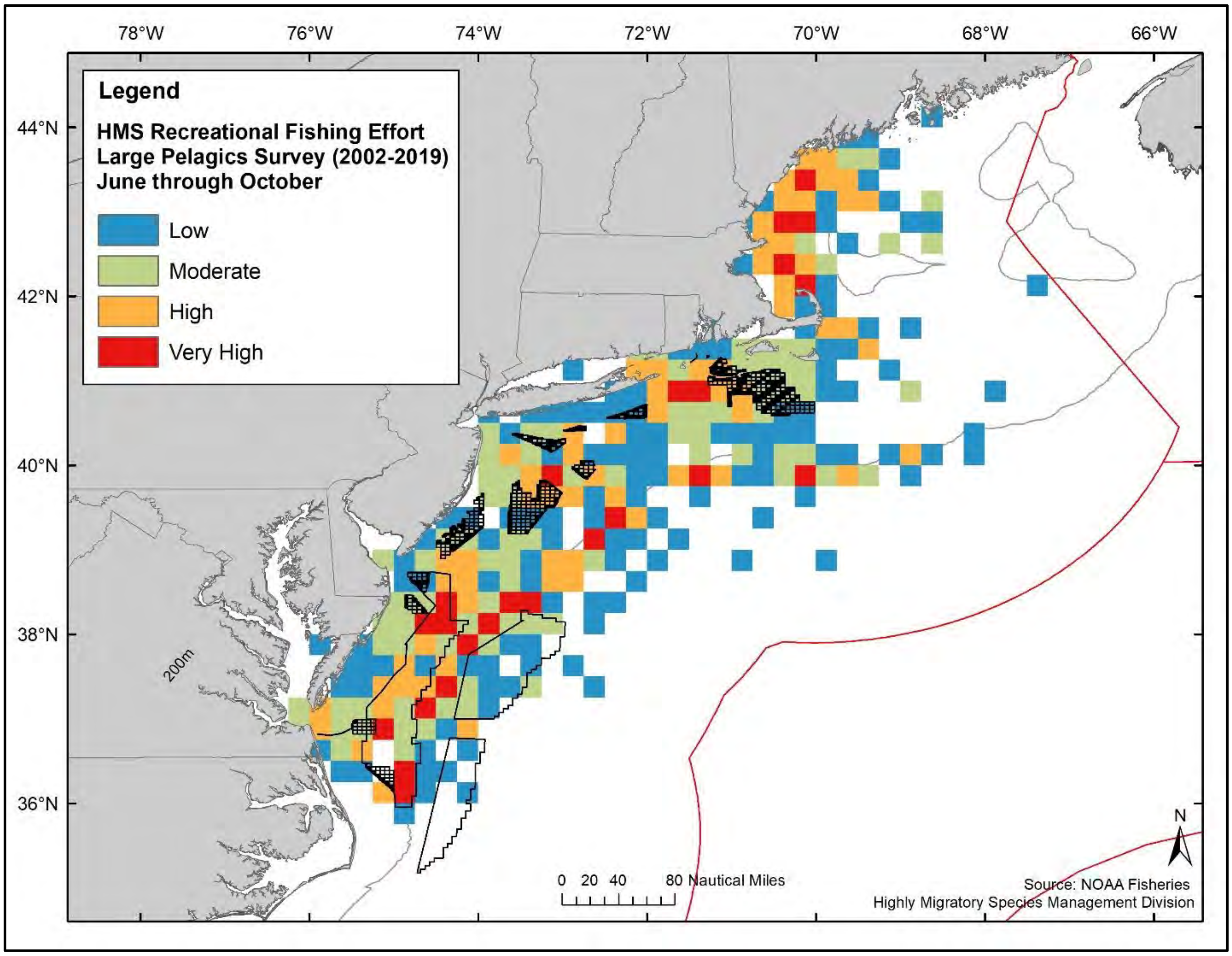
As shown in Figure 3.9-8, which presents spatial data indicating the relative intensity of charter fishing activity, the number of charter fishing trips is fairly low in the RI/MA WEA and along the proposed RWEC corridor.



Source: Adapted from BOEM (2019).

Figure 3.9-8. Distribution of vessel trip report data for charter vessels (2001–2010).

However, the for-hire recreational fishing effort for some targeted species is fairly high in and around the RI/MA WEA. For example, Figure 3.9 9 shows a considerable level of effort for highly migratory species, including tuna and sharks, near the area based on for-hire recreational vessel logbook data from 2002 through 2019.



Source: NMFS (2023e)

Figure 3.9-9. Distribution of highly migratory species recreational fishing effort (2002–2019).

Most for-hire boats fishing near the RI/MA WEA are based in Rhode Island. However, party and charter boats from New York, Connecticut, and Massachusetts also regularly fish in or near the RI/MA WEA. For-hire recreational fishing is an integral part of each of these states' coastal tourism industries. From 2007 to 2012, annual for-hire boat revenue averaged $15.6 million in Rhode Island, $86.2 million in New York, $14.5 million in Connecticut, and $62.4 million in Massachusetts. However, of the 16,569 average annual for-hire boat trips that left from ports in the four states each year from 2007 to 2012, only 0.9% occurred in or near the RI/MA WEA (Kirkpatrick et al. 2017).

The 70 square miles of Cox Ledge excluded from the RI/MA WEA is important to for-hire recreational fishing and commercial fisheries. Table 3.9-18 presents data on party/charter recreational fishing reported on Cox Ledge during various time periods. The data suggest that a small number of for-hire recreational fishing businesses fish relatively intensively on Cox Ledge, with each individual business generating on the order of $9,400 per year in the area. The revenue reported on Cox Ledge is consistently high across all time periods studied (NEFMC and NMFS 2016).

Table 3.9-18. For-Hire Recreational Fishing Activity on the Portion of Cox Ledge Excluded from Wind Energy Development by Time Period

Time Period	Average Annual Revenue	Average Revenue Per Trip	Average Annual Number of Permit Holders	Average Annual Number of Anglers
2006–2014	$95,911	$2,385	10	887
2010–2014	$88,928	$2,257	9	816
2012–2014	$64,696	$2,521	6	587

Source: NEFMC and NMFS (2016).

3.9.1.2.2 Lease Area

Table 3.9-19 lists the top nine species most frequently kept on party/charter boat trips in the Lease Area from 2008 through 2019.

Table 3.9-19. For-Hire Recreational Fishing Landings in the Lease Area by Species (2008–2019 average)

Species	Average Annual Number of Fish	Average Annual Number of Fish as a Percentage of Total Fish Landed in the Lease Area
Black sea bass	129	5.8%
Bluefish	368	16.5%
Cod	26	1.2%
Cunner	962	43.2%
Dogfish spiny	37	1.7%
Red hake	8	0.3%
Scup	1	0.0%
Striped bass	586	26.3%
Summer flounder	1	0.1%
All others	109	4.9%
Total	**2,226**	**100.0%**

Source: NMFS (2023d).

Notes: Trips with no VTR are not reflected in this table. Many Atlantic-permitted vessels for highly migratory species do not have a VTR requirement (NMFS 2023d). Therefore, this table may not accurately report highly migratory species landings in the Lease Area.

The category “All Others” refers to species with less than three permits impacted to protect data confidentiality.

From 2009 to 2019, an average of five for-hire recreational fishing operations fished in the Lease Area each year. All of these fishing operations are small businesses. as defined by the Small Business Administration (NMFS 2023d). To understand the relative importance of the Lease Area to for-hire recreational fishing in the Mid-Atlantic and New England Regions as a whole, Table 3.9-20 compares the vessel trips and angler trips reported in the Lease Area to the total for-hire recreational fishing effort in the Mid-Atlantic and New England Regions from 2008 to 2019. The Lease Area annually accounted for 0.19% or less of the total vessel trips and 2.64% or less of the total angler trips. Based on marine angler expenditure survey data, from 2008 through 2019, trips in the Lease Area annually generated an average of $43,083 (in 2019 dollars) in revenue across all for-hire fishing operations, with a low of $3,000 in 2008 and a high of $77,000 in 2014 (NMFS 2023d). This revenue amount is a small fraction of the total earned by regional for-hire fishing operations. As described above, from 2007 through 2012, annual for-hire boat revenue averaged $15.6 million in Rhode Island, $86.2 million in New York, $14.5 million in Connecticut, and $62.4 million in Massachusetts.

Table 3.9-20. Annual For-Hire Recreational Fishing Vessel Trips and Angler Trips in the Lease Area (2008–2019)

Year	Average Annual Number of Vessel Trips	Average Annual Vessel Trips as a Percentage of Total Vessel Trips in the Mid-Atlantic and New England Regions	Average Annual Number of Angler Trips	Average Annual Angler Trips as a Percentage of Total Angler Trips in the Mid-Atlantic and New England Regions
2008	5	0.02	32	0.77
2009	7	0.03	60	0.62
2010	33	0.10	429	1.18
2011	35	0.11	431	1.97
2012	33	0.11	606	2.07
2013	24	0.08	313	1.27
2014	22	0.08	689	1.15
2015	27	0.10	574	2.22
2016	33	0.13	660	2.05
2017	44	0.19	594	2.64
2018	11	0.05	97	1.79
2019	31	0.16	197	1.24

Source: NMFS (2023d).

Notes: The term "vessel trips" refers to the number of party/charter VTRs submitted to NMFS where landings of any species were recorded; the term "angler trips" refers to the number of reported passengers on party/charter VTRs.

Data provided in NMFS (2023d) were used to analyze differences in the economic importance of fishing grounds in the Lease Area across for-hire recreational fishing operations. These data summarize the percentage of each federally permitted party/charter vessel's total angler trips coming from within Lease area. The vessel-level angler trip percentages were divided into quartiles, which were created by ordering the data from the lowest to highest percentage and then dividing the data into four groups of equal size. The first quartile represents the lowest 25% of ranked percentages, whereas the fourth quartile represents the highest 25%. In addition, the data provided in NMFS (2023d) reported the number of "outlier" vessels in the distribution of percentage of angler trips. In the context of this analysis, an outlier is a vessel that had an exceptionally high proportion of its annual angler tips coming from the Lease Area in comparison to other vessels that fished in the area.

From 2008 through 2021, the vessel ranked as the seventy-fifth percentile vessel (i.e., the vessel in the third quartile with the greatest dependence on the Lease Area over the 14-year period) had 5% of its total angler trips coming from the Lease Area (NMFS 2023d). Of the outliers, the vessel with the greatest dependence on the Lease Area had 42% of its total angler trips coming from the area in 2017. In short, some vessels depended heavily on the Lease Area, but most vessels derived a small percentage of their total annual revenue from the area.

Table 3.9-21 shows the annual vessel trips and angler trips reported in the Lease Area by port of departure. For-hire recreational vessels based in Point Judith and Montauk were the most dependent on the Lease Area. From 2008 through 2019, Point Judith accounted for 49% of the vessel trips in the Lease Area and 62% of the angler trips; Montauk accounted for 31% of the vessel trips in the Lease Area and 31% of the angler trips.

Table 3.9-21. Annual For-Hire Recreational Fishing Vessel Trips and Angler Trips in the Lease Area by Port (2008–2019)

Year	Trip Type	Point Judith, Rhode Island	Other Rhode Island Ports*	Montauk, New York	Other New York Ports*	All Massachusetts Ports	All Connecticut Ports	Total
2008	Vessel trips	4	1	0	0	0	0	**5**
	Angler trips	28	4	0	0	0	0	**32**
2009	Vessel trips	5	2	0	0	0	0	**7**
	Angler trips	52	8	0	0	0	0	**60**
2010	Vessel trips	14	0	17	1	0	1	**33**
	Angler trips	172	0	242	3	0	12	**429**
2011	Vessel trips	16	1	18	0	0	0	**35**
	Angler trips	314	11	106	0	0	0	**431**
2012	Vessel trips	19	1	11	0	1	1	**33**
	Angler trips	378	3	218	0	1	6	**606**
2013	Vessel trips	15	2	0	6	1	0	**24**
	Angler trips	237	11	0	62	3	0	**313**
2014	Vessel trips	17	0	5	0	0	0	**22**
	Angler trips	457	0	232	0	0	0	**689**
2015	Vessel trips	10	3	11	1	2	0	**27**
	Angler trips	265	8	292	4	5	0	**574**
2016	Vessel trips	25	0	5	0	3	0	**33**
	Angler trips	539	0	103	0	18	0	**660**
2017	Vessel trips	14	0	29	0	1	0	**44**
	Angler trips	351	0	241	0	2	0	**594**

Year	Trip Type	Point Judith, Rhode Island	Other Rhode Island Ports*	Montauk, New York	Other New York Ports*	All Massachusetts Ports	All Connecticut Ports	Total
2018	Vessel trips	6	0	0	2	3	0	**11**
	Angler trips	78	0	0	10	9	0	**97**
2019	Vessel trips	4	0	0	0	27	0	**31**
	Angler trips	38	0	0	0	159	0	**197**
Average 2008–2019	**Vessel trips**	**149**	**10**	**96**	**10**	**38**	**2**	**305**
	Angler trips	**2,909**	**45**	**1,434**	**79**	**197**	**18**	**4,682**

Source: NMFS (2023b).

Notes: The term “vessel trips” refers to the number of party/charter VTRs submitted to NMFS where landings of any species were recorded; the term “angler trips” refers to the number of reported passengers on party/charter VTRs.

* “Other Rhode Island Ports” and “Other New York Ports” refer to ports with less than three permits to protect data confidentiality.

3.9.2 Environmental Consequences

3.9.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

This EIS analyzes the maximum-case scenario; any potential variances in the proposed Project build-out as defined in the PDE would result in impacts similar to or less than those described in the sections below. The proposed PDE parameters (see Appendix D) in Table 3.9-22 would influence the magnitude of the impacts on commercial fisheries and for-hire recreational fishing.

Table 3.9-22. Project Design Envelope Parameters That Could Reduce Impacts

Parameter	Influence
The number, size, and location/orientation of WTGs	Reducing the number and size of the WTGs and changing their location/orientation could increase access to fishing grounds, reduce allisions, and reduce impacts on targeted species.
Total length and route of IACs and offshore export cables, including ability to reach target burial depths	Reducing the length and changing the route of IACs and offshore export cables, together with reaching target burial depths, could increase access to fishing grounds, reduce impacts on targeted species, and decrease gear loss/damage.
Number of simultaneous vessels, number of trips, size of vessels, and marine traffic routes to and from the Lease Area	Reducing the number of simultaneous vessels, number of trips, and size of vessels, together with changing marine traffic routes, could reduce vessel collisions and decrease use of port facilities.
Time of year during which construction occurs	Changing the time of year during which construction occurs could increase access to fishing grounds and reduce impacts on targeted species.

EPMs implemented during construction, O&M, and decommissioning would decrease the potential for impacts to commercial fisheries and for-hire recreational fishing (see Table F-1 in Appendix F). These EPMs would be implemented across all alternatives; therefore, BOEM would not expect measurable potential variances in impacts across the alternatives.

See Appendix E1 for a summary of IPFs analyzed for commercial fisheries and for-hire recreational fishing across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have a negligible adverse effect are excluded from Chapter 3 and provided in Appendix E1, Table E2-12.

Table 3.9-23 provides a summary of IPF findings carried forward for analysis in this section. A detailed analysis of the Proposed Action is provided following the table. Detailed analysis of other considered action alternatives is also provided below the table if analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component.

The Conclusion section within each alternative analysis discussion includes rationale for the effects determinations. Under all of the alternatives, the overall impact to commercial fisheries and for-hire recreational fishing from any alternative would be **moderate** adverse as mitigation would reduce adverse impacts substantially during the life of the proposed Project, including decommissioning; the affected activity or community would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts of the Project; or once the impacting agent is gone, the affected activity or community, including traditional cultural practices, is expected to return to a condition with no measurable impacts, when remedial or mitigating action is taken.

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Table 3.9-23. Comparison of Evaluated Impact-Producing Factors under Action Alternatives for Commercial Fisheries and For-Hire Recreational Fishing

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
Accidental releases and discharges	**Offshore**: Construction and O&M activities related to offshore wind energy development that reduce water quality could have a physiological or behavioral impact on some species targeted by commercial and for-hire recreational fisheries in the GAA. For any given offshore wind energy project, the impacts of accidental releases and discharges on target species catch in commercial and for-hire recreational fisheries are expected to be localized and short term. The intensity of impacts is anticipated to be **negligible** adverse.	**Offshore**: Project construction activities that reduce water quality could have a physiological or behavioral impact on some species targeted by commercial and for-hire recreational fisheries in the GAA. In turn, these impacts could decrease target species catch rates. The impacts during Project construction, O&M, and decommissioning from Project-related accidental releases and discharges on target species catch in commercial and for-hire recreational fisheries are expected to be localized, and the intensity of impacts is anticipated to be **negligible** adverse. The effects could be short term to long term depending on the type and volume of material released. The impacts of accidental releases and discharges of the Proposed Action on the target species catch of commercial and for-hire recreational fisheries would be undetectable or noticeable. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be short term to long term **negligible** to **minor** adverse.	**Offshore**: By omitting certain WTG positions, Alternatives C through F would reduce the impact of accidental releases and discharges on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing. However, the impact of accidental releases and discharges on finfish and invertebrates would be similar to that for the Proposed Action. Therefore, the impact of accidental releases and discharges to commercial fisheries and for-hire recreational fishing in the GAA would be similar to the Proposed Action: short term to long term **negligible** adverse for all design configurations analyzed. For all design configurations analyzed, the accidental releases and discharges impact of Alternatives C through F on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: short term to long term **negligible** to **minor** adverse.				**Offshore**: By omitting certain WTG positions, Alternative G would reduce the impact of accidental releases and discharges on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing. However, the impact of accidental releases and discharges on finfish and invertebrates would be similar to that for the Proposed Action. Therefore, the impact of accidental releases and discharges to commercial fisheries and for-hire recreational fishing in the GAA would be similar to the Proposed Action: short term to long term **negligible** adverse for all design configurations analyzed. The accidental releases and discharges impact of Alternative G on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: short term to long term **negligible** to **minor** adverse.
Anchoring	**Offshore**: Anchoring vessels used in the construction of offshore wind energy projects could pose a navigational hazard to commercial and for-hire recreational fishing vessels in the GAA. All impacts would be localized (within a few hundred yards of anchored vessel) and temporary (hours to days). Therefore, the effects of offshore wind energy-related anchoring on commercial fisheries and for-hire recreational fishing are expected to be short term **negligible** to **moderate** adverse.	**Offshore**: Anchoring vessels used in the construction of the Project could pose a navigational hazard to commercial and for-hire recreational fishing vessels in the GAA. All anchoring impacts would be localized (within a few hundred yards of an anchored vessel) and temporary (hours to days). Therefore, the adverse effects of Project-related anchoring on commercial fisheries and for-hire recreational fishing are expected to be short term **negligible** to **minor**. Although anchoring impacts would occur primarily during Project construction, some impacts could occur during O&M. Therefore, the adverse effects of Project-related anchoring on commercial fisheries and for-hire recreational fishing are expected to be short term **negligible** to **minor**. Decommissioning of the RWF and RWEC would lead to impacts similar to those generated during construction.	**Offshore**: The anchoring impact on navigation and vessel traffic under Alternatives C through F would be similar to the Proposed Action. Therefore, the impact of anchoring to commercial fisheries and for-hire recreational fishing in the GAA would be similar to that of the Proposed Action: short term **negligible** to **minor** adverse for all design configurations analyzed. For all design configurations analyzed, the anchoring impact of Alternatives C through F on navigation and vessel traffic would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: short term **negligible** to **moderate** adverse.				**Offshore**: The anchoring impact on navigation and vessel traffic under Alternative G would be similar to the Proposed Action. Therefore, the impact of anchoring to commercial fisheries and for-hire recreational fishing in the GAA would be similar to that of the Proposed Action: short term **negligible** to **minor** adverse for all design configurations analyzed. The anchoring impact of Alternative G on navigation and vessel traffic would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: short term **negligible** to **moderate** adverse.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
		Impacts from anchoring due to present and future military, survey, commercial, and recreational activities, including the Proposed Action, could pose a navigational hazard to commercial and for-hire recreational fishing vessels in the GAA. The anchoring impacts of the Proposed Action on commercial and for-hire recreational fisheries would be undetectable or noticeable. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be short term **negligible** to **moderate** adverse.					
Climate change	**Offshore**: Impacts on commercial fisheries and for-hire recreational fishing in the GAA are expected to result from climate change trends such as increased magnitude or frequency of storms, shoreline changes, ocean acidification, and water temperature changes. The intensity of impacts from climate change trends to commercial fisheries and for-hire recreational fishing is anticipated to qualify as **minor** to **major** adverse for those fishing operations targeting species adversely affected by climate change trends, and the beneficial impacts are anticipated to qualify as **minor** to **major** for those fishing operations targeting species beneficially affected by climate change trends. As they become operational, future offshore wind facilities would produce fewer GHG emissions than fossil fuel–powered generating facilities with similar capacities. However, given the global scale of GHG emissions, the benefits would be **negligible**.	**Offshore**: The types of impacts from global climate change trends to commercial fisheries and for-hire recreational fishing described for the No Action Alternative would occur under the Proposed Action. These impacts are expected to be long term **minor** to **major** adverse for those fishing operations targeting species adversely affected by climate change trends, and **minor** to **major** beneficial for those fishing operations targeting species beneficially affected by climate change trends. As they become operational, future offshore wind facilities, including the Proposed Action, would produce fewer GHG emissions than fossil fuel–powered generating facilities with similar capacities. However, given the global scale of GHG emissions, the benefits would be **negligible**.	**Offshore**: The impact of climate change trends under Alternatives C through F due to a change in GHG emissions would be similar to the Proposed Action: for all design configurations analyzed, long term **minor** to **major** adverse for fishing operations targeting species adversely affected by climate change trends, and **minor** to **major** beneficial for fishing operations targeting species beneficially affected by climate change trends. For all design configurations analyzed, the impact of Alternatives C through F on GHG emissions would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: long term **negligible** beneficial.				**Offshore**: The impact of climate change trends under Alternative G due to a change in GHG emissions would be similar to the Proposed Action: for all design configurations analyzed, long term **minor** to **major** adverse for fishing operations targeting species adversely affected by climate change trends, and **minor** to **major** beneficial for fishing operations targeting species beneficially affected by climate change trends. The impact of Alternative G on GHG emissions would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: long term **negligible** beneficial.
Light	**Offshore**: Construction and O&M activities related to offshore wind energy development that introduce artificial lighting could result in behavioral responses from some target species. For any given offshore wind energy project, adverse lighting impacts on target species catch in commercial and for-hire recreational fisheries are expected to be	**Offshore**: Project construction, O&M, and decommissioning activities that introduce artificial lighting could result in behavioral responses from some target species. Project EPMs include construction vessel light shielding and operational restrictions to limit light use to required periods and minimize artificial lighting effects on the environment. Project-related lighting impacts on target species catch in commercial and for-hire	**Offshore**: By omitting certain WTG positions, Alternatives C through F would reduce the impact of lighting on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing. However, the impact of lighting on finfish and invertebrates would be similar to that for the Proposed Action. Therefore, the impact of lighting on commercial fisheries and for-hire recreational fishing in the GAA would be similar to that for the Proposed Action: long term **negligible** to **minor** adverse for all design configurations analyzed. For all design configurations analyzed, the lighting impact of Alternatives C through F on finfish and invertebrate resources important to commercial fisheries and for-hire				**Offshore**: By omitting certain WTG positions, Alternative G would reduce the impact of lighting on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing. However, the impact of lighting on finfish and invertebrates would be similar to that for the Proposed Action. Therefore, the impact of lighting on commercial fisheries and for-hire recreational

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	localized and long term. The intensity of impacts is anticipated to be **minor** to **moderate** adverse.	recreational fisheries are expected to be localized and long term. The intensity of impacts resulting from lighting are anticipated to be **negligible** to **minor** adverse. The adverse lighting impacts from ongoing and future offshore activities, including the Proposed Action, on the target species catch of commercial and for-hire recreational fisheries are expected to be localized and short term. The light impacts of the Proposed Action on commercial and for-hire recreational fisheries would be undetectable. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be long term **minor** to **moderate** adverse.	recreational fishing would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: long term **negligible** to **minor** adverse.				fishing in the GAA would be similar to that for the Proposed Action: long term **negligible** to **minor** adverse for all design configurations analyzed. The lighting impact of Alternative G on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: long term **negligible** to **minor** adverse.
New cable emplacement/maintenance and EMF	**Offshore**: Approximately 11,816 miles of offshore export and IACs could be installed along the U.S. East Coast to support future offshore wind energy projects. To the fullest extent possible, future offshore wind energy projects would reduce the occurrence of accidental snagging of fishing gear by burying all cables beneath the seafloor. Therefore, the impact of buried submarine cables to commercial fisheries and for-hire recreational fishing through entanglement or gear loss or damage is expected to be long term **moderate** adverse. The impacts of EMF generated by submarine cables on commercial fisheries and for-hire recreational fishing are also expected to be long term but **negligible** to **minor** adverse.	**Offshore**: The installation of the offshore export and IACs could temporarily restrict vessel movement and thus transit and harvesting activities in the Lease Area and along the RWEC. To the fullest extent possible, Revolution Wind would reduce the occurrence of accidental snagging of fishing gear by burying all cables beneath the seafloor. The impact of submarine cables to commercial fisheries and for-hire recreational fishing through entanglement or gear loss/damage is expected to be long term **negligible** to **minor** adverse where cable burial can occur and long term **moderate** adverse where cable burial cannot occur. EMF levels, which are calculated using conservative assumptions likely to overestimate results, indicate that the magnetic-field and induced electric field produced by the Project cables would be below the detection thresholds for magnetosensitive and electrosensitive marine organisms. Consequently, EMF from Project cables are expected to have long term **negligible** to **minor** adverse impacts on commercial fisheries and for-hire recreational fishing. The cable emplacement/maintenance and EMF impacts of the Proposed Action on commercial and for-hire recreational fisheries would be undetectable or noticeable. When combined with the impacts of present and other reasonably foreseeable activities, the impact of submarine cables to commercial fisheries and for-hire	**Offshore**: If the number of IACs is reduced under Alternatives C through F, the adverse impact of new cable emplacement on commercial and for-hire recreational fisheries would be diminished during Project construction and O&M. In comparison to the Proposed Action, fishing access would be improved and the risk of fishing gear loss/damage would be reduced. However, the impact of new cable emplacement and maintenance on commercial fisheries and for-hire recreational fishing in the GAA would be similar to that for the Proposed Action: long term **negligible** to **minor** adverse where cable burial can occur and long term **moderate** adverse where cable burial cannot occur. Reducing the number of IACs would also decrease the potential adverse impacts of EMF generated by submarine cables on fish and invertebrates targeted by commercial and for-hire recreational fisheries. However, the impact of EMF on commercial fisheries and for-hire recreational fishing would be similar to that for the Proposed Action: long term **negligible** to **minor** adverse for all design configurations analyzed. For all design configurations analyzed, the new cable emplacement and maintenance and EMF impact of Alternatives C through F would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action for all design configurations: long term **negligible** to **minor** adverse for EFH, long term **negligible** to **minor** adverse for cable installation where cable burial can occur; long term **moderate** adverse for cable installation where cable burial cannot occur.				**Offshore**: If the number of IACs is reduced under Alternative G, the adverse impact of new cable emplacement on commercial and for-hire recreational fisheries would be diminished during Project construction and O&M. In comparison to the Proposed Action, fishing access would be improved and the risk of fishing gear loss/damage would be reduced. However, the impact of new cable emplacement and maintenance on commercial fisheries and for-hire recreational fishing in the GAA would be similar to that for the Proposed Action: long term **negligible** to **minor** adverse where cable burial can occur and long term **moderate** adverse where cable burial cannot occur. Reducing the number of IACs would also decrease the potential adverse impacts of EMF generated by submarine cables on fish and invertebrates targeted by commercial and for-hire recreational fisheries. However, the impact of EMF on commercial fisheries and for-hire recreational fishing would be similar to that for the Proposed Action: long term **negligible** to **minor** adverse for all design configurations analyzed. The new cable emplacement and maintenance and EMF impact of Alternative G would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational

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		recreational fishing through entanglement or gear loss/damage is expected to be long term **moderate** adverse and the impacts of EMF on commercial fisheries and for-hire recreational fishing are expected to be long term **negligible** to **minor** adverse.					fishing in the GAA would be similar to those under the Proposed Action for all design configurations: long term **negligible** to **minor** adverse for EFH, long term **negligible** to **minor** adverse for cable installation where cable burial can occur; long term **moderate** adverse for cable installation where cable burial cannot occur.
Noise	**Offshore**: Construction and O&M activities related to offshore wind energy development that increase underwater noise could result in behavioral responses from some target species, such as fish not biting at hooks or fish changing swim height. In turn, these responses could decrease the catch rates of target species, thereby reducing revenue for commercial fishing and for-hire recreational fishing businesses. Some sources of noise, such as vessels and pile driving during project construction, could cause some target species to temporarily move away from the source and disperse to other areas. These species are expected to return to the area after the noise ends. Alteration of the ambient noise environment during construction and O&M activities could also result in reduced reproductive success for some species, which could negatively impact catch levels in the fisheries targeting those species. The effects of operational underwater noise from future offshore wind energy projects would occur for the life of the projects but are not anticipated to have population-level effects on target species. For any given offshore wind energy project, all adverse noise impacts on target species catch in commercial and for-hire recreational fisheries are expected to be localized and short term during construction and long term during O&M. The intensity of impacts is anticipated to be **moderate** adverse.	**Offshore**: Project construction and O&M activities that increase underwater noise could cause behavioral responses from some marine target species or could result in reduced reproductive success for some species. These impacts, in turn, could negatively impact catch levels in the fisheries targeting those species. EPMs, together with an acoustic monitoring plan, are expected to reduce impacts to target species. Therefore, Project-related noise is expected to have a short-term **moderate** adverse impact on the target species catch of commercial fisheries and for-hire recreational fishing during construction, and a long-term **moderate** adverse impact during O&M. Decommissioning of the RWF and RWEC would lead to impacts similar to those generated during construction. For any given activity, all adverse cumulative noise impacts on the target species catch of commercial and for-hire recreational fisheries are expected to be localized. The noise impacts of the Proposed Action on commercial and for-hire recreational fishing would be undetectable or noticeable. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be long term **moderate** adverse.	**Offshore**: By omitting certain WTG positions, Alternatives C through F would reduce the impact of noise on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing. However, the impact of noise on finfish and invertebrates would be similar to that for the Proposed Action. Therefore, for all design configurations analyzed, the impact of noise to commercial fisheries and for-hire recreational fishing in the GAA would be similar to that for the Proposed Action: short term **moderate** adverse during construction and decommissioning and long term **moderate** adverse during O&M. For all design configurations analyzed, the noise impact of Alternatives C through F on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: long term **moderate** adverse.				**Offshore**: By omitting certain WTG positions, Alternative G would reduce the impact of noise on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing. However, the impact of noise on finfish and invertebrates would be similar to the Proposed Action. Therefore, for all design configurations analyzed, the impact of noise to commercial fisheries and for-hire recreational fishing in the GAA would be similar to the Proposed Action: short term **moderate** adverse during construction and decommissioning and long term **moderate** adverse during O&M. The noise impact of Alternative G on finfish and invertebrate resources important to commercial fisheries and for-hire recreational fishing would be similar to the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to the Proposed Action: long term **moderate** adverse.
Port utilization	**Onshore**: Offshore wind energy projects would require vessels for staging and	**Onshore**: Several port facilities located in New York, Rhode Island, Massachusetts, and	**Onshore**: Construction and O&M of onshore facilities under Alternatives C through F would not be markedly different from the Proposed Action; therefore, impacts to commercial				**Onshore**: Construction and O&M of onshore facilities under Alternative G would not be

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	installation during construction and for routine maintenance during operations. This additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to high-demand port services (e.g., fueling and provisioning) by existing port users, including commercial fishing vessels and for-hire recreational fishing vessels. The use of multiple ports to support offshore wind energy project development would reduce the related congestion impacts in any one port. Therefore, port utilization impacts to commercial fisheries and for-hire recreational fishing are expected to be localized long term **minor** to **moderate** adverse.	Connecticut are considered for offshore Project construction, staging, and fabrication as well as crew transfer and logistics support. Although final port selection has not been determined at this time, the list of affected commercial ports could include ports used by commercial fishing vessels and for-hire recreational fishing vessels. Vessels for staging and installation during construction would add traffic to port facilities. The additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to high-demand port services (e.g., fueling and provisioning) by existing port users, including commercial fishing vessels and for-hire recreational fishing vessels. As a result, the adverse impact on commercial fisheries and for-hire recreational fishing would be short term **minor** to **moderate**. During Project O&M, port facilities would be required for vessels used for routine maintenance of offshore Project components. These vessels would require berthing and would add traffic to port facilities. Given the low number of vessels required for Project O&M, the adverse impacts on the accessibility of port facilities by commercial fishing vessels and for-hire recreational fishing vessels would be long term **minor**. Decommissioning of the RWF and RWEC would lead to impacts similar to those generated during construction. The major ports in the GAA are anticipated to continue to have increasing vessel visits, and vessel size is also expected to increase. Future offshore wind energy projects, including the Project, would contribute to the increase in vessel traffic. The port utilization impacts of the Proposed Action on commercial and for-hire recreational fisheries would be noticeable. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be long term **minor** to **moderate** adverse.	fisheries and for-hire recreational fishing in the GAA would be the same as those described for the Proposed Action: short term **minor** to **moderate** adverse during construction, and long term **minor** adverse during operations for all design configurations analyzed. For all design configurations analyzed, the port utilization impact of Alternatives C through F to commercial fisheries and for-hire recreational fishing would be similar to that of the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to those under the Proposed Action: long term **minor** to **moderate** adverse.				markedly different from the Proposed Action; therefore, impacts to commercial fisheries and for-hire recreational fishing in the GAA would be the same as the Proposed Action: short term **minor** to **moderate** adverse during construction, and long term **minor** adverse during operations for all design configurations analyzed. The port utilization impact of Alternative G to commercial fisheries and for-hire recreational fishing would be similar to the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to the Proposed Action: long term **minor** to **moderate** adverse.
Presence of structures	**Offshore**: The presence of structures can lead to impacts on commercial fisheries and for-hire recreational fishing through reduced catch levels of target species; increased space-use conflicts that may result in navigation hazards, allisions, and	**Offshore**: The installation of offshore Project components, including the WTGs and export cables, could temporarily restrict vessel movement and thus transit and harvesting activities in the Lease Area and along the RWEC. To safeguard mariners from the hazards associated with	**Offshore**: See Section 3.9.2.4 for the detailed analysis. In general, the impacts on commercial fisheries from the presence of structures would be the same or similar to the Proposed Action. However, by omitting certain WTG positions, Alternatives C through E would reduce the estimated annual revenue at risk across all FMP and non-FMP fisheries in the Lease Area and along the RWEC during construction, and the estimated annual exposed revenue for all FMP and non-FMP fisheries as a percentage of total revenue in the				**Offshore**: See Section 3.9.2.5 for the detailed analysis. In general, the presence of structures impacts on commercial fisheries would be the same or similar to the Proposed Action. However, by omitting certain WTG positions, Alternative G would reduce the estimated

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	gear loss/damage; and interference with NMFS's ongoing scientific research and protected species surveys. During construction of offshore wind energy projects, temporary or permanent habitat alterations could occur, but the impact of these alterations on invertebrate and fish populations would be **negligible** to **minor** adverse. Therefore, the adverse impacts to fisheries that target affected species would be short term or long term **negligible** to **minor**. Construction activities could overlap with the spawning habitat and/or spawning season of a number of target species, leading to potential short-term **negligible** to **moderate** adverse impacts to the productivity and recruitment success of these species. Therefore, the adverse impact to fisheries that target these species is expected to be short term **negligible** to **moderate** adverse. Once offshore components are installed, the presence of the WTG and OSS foundations and associated scour protection would reduce the habitat for some target species and increase the habitat for others. Overall, localized adverse or beneficial impacts on target species populations from habitat alteration would have a long-term **negligible** to **moderate** effect on the target species catch of commercial and for-hire recreational fisheries. With respect to impacts related to increased space-use conflicts, fishing revenue would be foregone if these conflicts cause fishing vessel operators to no longer fish in affected areas, and they cannot capture that revenue in different locations. The annual commercial fishing revenue exposed at the end of the project development timeline for all planned offshore wind energy lease areas in the New England and Mid-Atlantic regions is estimated to be about $34.0 million. This annual exposed revenue represents 3.6% of the average annual revenue for all FMP	construction of the Project, Revolution Wind would request, and it is expected the USCG would establish, temporary safety zones around each WTG site and each cable laying vessel. Non-construction vessels would be prohibited from entering into, transiting through, mooring in, or anchoring within the safety zones while construction vessels and associated equipment are working on-site. During Project construction, temporary or permanent habitat alterations could occur, but the impact of these alterations on invertebrate and fish populations would be **negligible** to **minor** adverse. Therefore, the adverse impacts to fisheries that target affected species would be short term or long term **negligible** to **minor**. Construction activities could overlap with the spawning habitat and/or spawning season of a number of target species, leading to potential short-term **negligible** to **moderate** adverse impacts to the productivity and recruitment success of these species. Therefore, the adverse impact to fisheries that target these species is expected to be short term **negligible** to **moderate** adverse. Once offshore components are installed, the presence of the WTG and OSS foundations and associated scour protection would reduce the habitat for some target species and increase the habitat for others. Overall, localized adverse or beneficial impacts on target species populations from habitat alteration would have a long-term **negligible** to **moderate** effect on the target species catch of commercial and for-hire recreational fisheries. The annual revenue at risk across all FMP and non-FMP fisheries in the Lease Area and along the RWEC during Project construction and O&M is estimated to be $1.42 million. This annual exposed revenue represents 0.99% of the average annual revenue for all FMP and non-FMP fisheries in the RFA. The largest impacts in terms of exposed revenue as a percentage of total revenue in the RFA would be in the Spiny Dogfish, American Lobster, and Atlantic Herring FMP fisheries. The gear type and port most affected in terms of exposed revenue as a percentage of total revenue in the RFA would be midwater trawl and Little Compton, RI, respectively.	RFA would be lower. The annual revenue at risk across all FMP and non-FMP fisheries in the Lease Area and along the RWEC during Project construction and O&M is estimated to range from $1.06 million under Alternative E1 to $1.37 million under Alternative D2. This range of annual exposed revenue represents 0.74% to 0.95% of the average annual revenue for all FMP and non-FMP fisheries in the RFA. Under all design configurations, the largest impacts in terms of exposed revenue as a percentage of total revenue in the RFA would be in the Spiny Dogfish, American Lobster, and Atlantic Herring FMP fisheries. The gear type and port most affected in terms of exposed revenue as a percentage of total revenue in the RFA would be midwater trawl and Little Compton, RI, respectively. During construction, the impact level from the presence of structures for all design configurations would be similar to the Proposed Action: short term **negligible** to **moderate** adverse for the majority of commercial fishing vessels but short term **major** adverse for a small number of vessels. During O&M, the impact level from the presence of structures for all design configurations would be similar to the Proposed Action: long term **negligible** to **moderate** adverse for the majority of commercial fishing vessels, but long term **major** adverse for a small number of vessels. The Direct Compensation Program, Coastal Community Funds, and fishing gear conflict prevention and claim procedure would reduce adverse economic impacts to commercial or for-hire recreational fishing operations during Project construction and O&M.				annual revenue at risk across all FMP and non-FMP fisheries in the Lease Area and along the RWEC during Project construction and O&M to $1.14 million, and the estimated annual exposed revenue for all FMP and non-FMP fisheries as a percentage of total revenue in the RFA would be 0.79%. The largest impacts in terms of exposed revenue as a percentage of total revenue in the RFA would be in the Spiny Dogfish, American Lobster, and Atlantic Herring FMP fisheries. The gear type and port most affected in terms of exposed revenue as a percentage of total revenue in the RFA would be midwater trawl and Little Compton, RI, respectively. During construction, the impact level from the presence of structures for all design configurations would be similar to the Proposed Action: short term **negligible** to **moderate** adverse for the majority of commercial fishing vessels but short term **major** adverse for a small number of vessels. During O&M, the impact level from the presence of structures for all design configurations would be similar to the Proposed Action: long term **negligible** to **moderate** adverse for the majority of commercial fishing vessels, but long term **major** adverse for a small number of vessels. The Direct Compensation Program, Coastal Community Funds, and fishing gear conflict prevention and claim procedure would reduce adverse economic impacts to commercial or for-hire recreational fishing operations during Project construction and O&M.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	and non-FMP fisheries in the New England and Mid-Atlantic regions. For those fishing vessels that derive a large percentage of their total revenue from areas where offshore wind facilities would be located, that choose to avoid these areas once the facilities become operational, and are unable to find suitable alternative fishing locations, the adverse impacts due to the presence of structures would be long term **major**. However, it is expected that most fishing vessels would only have to adjust somewhat to account for disruptions due to the presence of structures. Most derive a small percentage of their total revenue from any one lease area or would be able to relocate to other fishing locations. In addition, the impacts of offshore wind energy facilities could include long-term **minor** beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect. Therefore, BOEM expects that the impacts to commercial fisheries and for-hire recreational fishing resulting from the presence of structure would be long term **negligible** to **major** adverse, depending on the fishery and fishing operation. If BOEM's and Revolution Wind's recommendations related to project siting, design, navigation, access, safety measures, and financial compensation are implemented across all offshore wind energy projects, adverse impacts on commercial fisheries due to the presence of structures could be reduced. The offshore structures associated with offshore wind energy development could also affect commercial fisheries and for-hire recreational fishing by preventing or hampering NMFS's ongoing scientific surveys on which fishery management measures are based. If NMFS's scientific survey methodologies are not adapted to sample within wind energy facilities, there could be increased uncertainty in scientific	For those fishing vessels that derive a large percentage of their total revenue from those areas closed during Project construction and are unable to find suitable alternative fishing locations, the adverse impacts of safety zones would be temporarily **major**. However, most of the fishing vessels derive only a small percentage of their total revenue from areas where safety zones would be in effect. The impacts of safety zones on these fishing vessels are expected to be temporary **negligible** to **moderate** adverse. Considering the moderate revenue at risk across ports, together with the small number of vessels that depend heavily on the Lease Area, the impacts to other fishing industry sectors during Project construction, including seafood processors and distributors and shoreside support services, are expected to be temporary **minor** to **moderate** adverse. The Direct Compensation Program, Coastal Community Funds, and fishing gear conflict prevention and claim procedure are considered part of the Proposed Action and would reduce adverse economic impacts to commercial or for-hire recreational fishing operations during Project construction. The Proposed Action would result in the installation of 100 WTGs and two OSSs. Revolution Wind is committed to an indicative layout scenario with WTGs sited in a grid with approximately 1.15 mile (1 nm) × 1.15 mile (1 nm) spacing that aligns with other proposed adjacent offshore wind energy projects in the RI/MA WEA. This layout has been confirmed through expert analysis to allow for safe navigation without the need for additional designated transit lanes. However, BOEM is cognizant that maneuverability within the Lease Area could vary depending on factors such as vessel size, fishing gear or method used, and/or environmental conditions. The amount of fishing activity that could be affected during Project O&M is a small fraction of the amount of fishing activity in the Mid-Atlantic and New England regions as a whole. Nonetheless, for those fishing vessels that derive a large percentage of their total revenue from the Lease					

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	survey results, which would increase uncertainty in stock assessments and quota setting processes. This increased uncertainty, in turn, could result in more conservative catch quotas and/or more restrictive effort management measures for commercial and recreational fisheries.	Area, choose to avoid the Lease Area during Project O&M, and are unable to find suitable alternative fishing locations, the adverse impacts would be long term **major**. However, three-quarters of the vessels fishing in the Lease Area from 2008 through 2019 derived 0.88% or less of their total revenue from the area. Moreover, some fishing vessels that choose to avoid the Lease Area would likely be able to relocate to other fishing locations and continue to earn revenue. Therefore, the adverse impact of the presence of structures on the majority of vessels would be long term **negligible** to **moderate.** The impacts to other fishing industry sectors, including seafood processors and distributors and shoreside support services, would be long term **minor** to **moderate** adverse. The Direct Compensation Program, Coastal Community Funds, and fishing gear conflict prevention and claim procedure are considered part of the Proposed Action and would reduce adverse economic impacts to commercial or for-hire recreational fishing operations during Project O&M. Given the small footprint of the Lease Area and RWEC, any localized adverse impacts on target species populations from habitat alteration would have a **negligible** to **moderate** effect on the catch of for-hire recreational and commercial fisheries depending on the species targeted. The WTG and OSS foundations and associated scour protection could also produce an artificial reef effect and attract finfish and invertebrates. Although the effects of artificial reefs on species abundance are uncertain, with respect to the Project, it is expected that the reef effect of the WTG foundations would have long-term **negligible** to **minor** beneficial impacts to for-hire recreational fishing, depending on the extent to which the foundations attract targeted species. The potential for disruption of inshore to offshore migratory patterns of important species has been identified as a topic of concern. This potential effect would have long-term **negligible** to **minor** adverse impacts to commercial fisheries and for-hire recreational fishing, depending on the extent to					

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		which the foundations alter the migratory behaviors of targeted species. Decommissioning of the RWF and RWEC would lead to impacts similar to those generated during construction. Under the No Action Alternative, offshore wind energy development could result in the installation of 3,088 WTG and OSS foundations through 2030. The impact of the Project would be noticeable because it would add as many as 102 foundations, which is a 3% increase. The addition of these new structures and cables in the GAA could adversely impact commercial fisheries and for-hire recreational fishing due to potential increased space-use conflicts. In the event that these fishing operations are unable to find suitable alternative fishing locations, they could experience long-term **major** adverse impacts. However, it is expected that most fishing vessels would only have to adjust somewhat to account for disruptions due to the presence of structures. In addition, the impacts of offshore wind energy facilities could include long-term **minor** beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect. Project construction and O&M are expected to impact NMFS's ongoing scientific research surveys or protected species surveys. Refer to Section 3.17 for this analysis. Overall, BOEM expects that the cumulative impacts of the presence of structures resulting from the Project and other past, present, and reasonably foreseeable activities would be long term **moderate** to **major** adverse depending on the fishery and fishing operation. If BOEM's and Revolution Wind's recommendations related to Project siting, design, navigation, access, safety measures, and financial compensation are implemented across all offshore wind energy projects, adverse impacts on commercial fisheries due to the presence of structures could be reduced.					
Vessel traffic	**Offshore**: Construction of offshore wind energy projects would require staging and installation vessels, including crew transfer, dredging, cable lay, pile driving,	**Offshore**: Construction of the Project would require port facilities for staging and installation vessels, including crew transfer, dredging, cable lay, pile driving, survey vessels, and, potentially,	**Offshore**: Under Alternatives C through F, vessel traffic would be similar to the Proposed Action. Therefore, the impact to commercial fisheries and for-hire recreational fishing in the GAA would be similar to the Proposed Action: term **moderate** adverse for construction				**Offshore**: Under Alternative G, vessel traffic would be similar to the Proposed Action. Therefore, the impact to commercial fisheries and for-hire recreational fishing in the GAA

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	survey vessels, and potentially feeder lift barges and heavy lift barges. A more limited number of vessels would also be required for routine maintenance during the O&M phase. The additional vessel volume could cause vessel traffic congestion, difficulties with navigating, and an increased risk for collisions. These potential adverse impacts could cause some fishing vessel operators to change. In addition, once offshore wind energy projects are completed, some commercial fishermen could avoid the lease areas if large numbers of recreational fishermen are drawn to the areas by the prospect of higher catches. Overall, the vessel traffic effects on commercial fisheries and for-hire recreational fishing are expected to be short term **moderate** adverse during construction and long term **minor** to **moderate** adverse during O&M.	feeder lift barges and heavy lift barges. However, the Project-related increase in vessel traffic would be nominal when compared to existing vessel operations within the GAA. In addition, Revolution Wind would implement a comprehensive communication plan during offshore construction. As a result, the adverse impact on commercial fisheries and for-hire recreational fishing would be temporary and **moderate**. In comparison to the construction phase, Project O&M would require a more limited number of vessels, and most of the vessels would be smaller in size, although the number of vessel transits would increase during O&M. As a result of a less compressed time period, the increased vessel transits during O&M are not expected to result in a significant increase in the overall traffic volume or patterns. In addition, once the Project is completed, some commercial fishermen could avoid the lease areas if large numbers of recreational fishermen are drawn to the area by the prospect of higher catches. Overall, the vessel traffic effects on commercial fisheries and for-hire recreational fishing during Project O&M are expected to be long term **minor** to **moderate** adverse. Decommissioning of the RWF and RWEC would lead to impacts similar to those generated during construction. Future offshore wind energy projects, including the Project, would contribute to the increase in vessel traffic, but the risk of vessel collisions is expected to remain low. The vessel traffic impacts of the Proposed Action on commercial and for-hire recreational fishing would be noticeable. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be long term **minor** to **moderate** adverse.	and decommissioning and long term **minor** to **moderate** adverse for O&M under all design configurations analyzed. For all design configurations analyzed, the vessel traffic impact of Alternatives C through F would be similar to the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to the Proposed Action: long term **minor** to **moderate** adverse.				would be similar to the Proposed Action: term **moderate** adverse for construction and decommissioning and long term **minor** to **moderate** adverse for O&M under all design configurations analyzed. The vessel traffic impact of Alternative G would be similar to the Proposed Action. Therefore, the cumulative impacts to commercial fisheries and for-hire recreational fishing in the GAA would be similar to the Proposed Action: long term **minor** to **moderate** adverse.

3.9.2.2 Alternative A: Impacts of the No Action Alternative on Commercial Fisheries and For-Hire Recreational Fishing

3.9.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for commercial fisheries and for-hire recreational fishing (see Section 3.9.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the GAA. These IPFs are described and analyzed in Appendix E1.

Other ongoing activities within the GAA, including non–offshore wind activities that affect commercial and for-hire recreational fisheries, are generally associated with climate change trends and fisheries management activities. Ongoing impacts of climate change trends include increased magnitude or frequency of storms, shoreline changes, ocean acidification, and water temperature changes. Risks to fisheries associated with these events include the ability to safely conduct fishing operations (e.g., because of storms) and climate-related habitat or distribution shifts in targeted species. Fish and shellfish species are expected to exhibit variation in their responses to climate change trends, with some species benefiting from climate change trends and others being adversely affected (Hare et al. 2016). To the extent that impacts of climate change trends on targeted species result in a decrease in catch or increase in fishing costs, the profitability of businesses engaged in commercial fisheries and for-hire recreational fishing would be adversely affected.

Ongoing fisheries management activities of NMFS, federal regional fishery management councils, and coastal states affect commercial and for-hire recreational fisheries through stock assessments and management measures to ensure the continued existence of species at levels that will allow commercial and for-hire recreational fisheries to occur. For example, ongoing fishing restrictions designed to rebuild depleted stocks in the Northeast Multispecies (large-mesh) FMP fishery would continue to reduce landings in that fishery. If successful, however, these measures would ensure the sustainability of fishery resources, which would have a beneficial impact on fishery operations by maximizing sustainable yield of fishery resources over the long term.

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

- Continued O&M of the BIWF project (five WTGs) installed in state waters
- Continued O&M of the Coastal Virginia Offshore Wind project (two WTGs) installed in OCS-A 0497
- Ongoing construction of two offshore wind projects: the Vineyard Wind 1 project (62 WTGs and 1 OSS) in OCS-A 0501 and the SFWF project (12 WTGs and 1 OSS) in OCS-A 0517

The construction effects of the Vineyard Wind 1 and SFWF projects have been evaluated through previous NEPA reviews (BOEM 2021b, 2021c). Ongoing O&M of the BIWF and Coastal Virginia Offshore Wind projects and ongoing construction of the Vineyard Wind 1 and SFWF projects would affect commercial fisheries and for-hire recreational fishing through the primary IPFs of anchoring, noise, port utilization, vessel traffic, presence of structures, and cable emplacement and maintenance. Ongoing offshore wind activities would have the same type of impacts from anchoring, noise, port utilization, vessel traffic, presence of structures, and cable emplacement and maintenance that are described in detail in Section 3.9.3.2.2 for planned offshore wind activities, but the impacts would be of lower intensity.

3.9.2.2.2 Cumulative Impacts

This section discloses potential impacts to commercial fisheries and for-hire recreational fishing associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

Offshore Activities and Facilities

Accidental releases and discharges: Construction and O&M activities related to offshore wind energy development that reduce water quality could have a physiological or behavioral impact on some species targeted by commercial and for-hire recreational fisheries in the GAA. In turn, these impacts could decrease target species catch rates. BOEM prohibits the discharge or disposal of solid debris into offshore waters during any activity associated with the construction and operations of offshore energy facilities (30 CFR 585.105(a)). The USCG similarly prohibits the dumping of trash or debris capable of posing entanglement or ingestion risk (MARPOL, Annex V, Public Law 100−220 (101 Stat. 1458)). Compliance with these requirements would effectively minimize releases of water quality contaminants and trash or debris. For any given offshore wind energy project, the impacts of accidental releases and discharges on target species catch in commercial and for-hire recreational fisheries are expected to be localized and short term. The intensity of impacts is anticipated to be **negligible** adverse. Details regarding the potential impacts of accidental releases and discharges to finfish and EFH are described in Section 3.13.

Anchoring: Anchoring vessels used in the construction of offshore wind energy projects could pose a navigational hazard to commercial and for-hire recreational fishing vessels in the GAA. Although anchoring impacts would occur primarily during construction, some impacts could also occur during O&M and decommissioning. All impacts would be localized (within a few hundred yards of anchored vessel) and temporary (hours to days). Therefore, the adverse effects of offshore wind energy-related anchoring on commercial fisheries and for-hire recreational fishing are expected to be short term **negligible** to **moderate**.

Climate change: Impacts on commercial fisheries and for-hire recreational fishing in the GAA are expected to result from climate change trends such as increased magnitude or frequency of storms, shoreline changes, ocean acidification, and water temperature changes. Risks to fisheries associated with these events include habitat/distribution shifts, disease incidence, and risk of invasive species. If these risk factors result in a decrease in catch and/or increase in fishing costs (e.g., transiting time), the profitability of businesses engaged in commercial fisheries and for-hire recreational fishing would be adversely affected. The catch potential for the temperate Northeast Atlantic is projected to decrease between now and the 2050s (Barange et al. 2018). Hare et al. (2016) predicted that climate change would affect northeast fishery species differently. For approximately half of the 82 species assessed, the authors report that overall climate vulnerability is high to very high; diadromous fish and benthic invertebrate species exhibit the greatest vulnerability. In addition, most species included in the assessment have a high potential for a change in distribution in response to projected changes in climate. Adverse effects of climate change trends are expected for approximately half of the species assessed; however, some species are expected to increase in stock distribution and/or productivity (Hare et al. 2016). The intensity of the impacts of climate change trends to commercial fisheries and for-hire recreational fishing is anticipated to qualify as **minor** to **major** adverse for those fishing operations targeting species adversely affected by climate change trends, and the beneficial impacts are anticipated to qualify as **minor** to **major** for those fishing operations targeting species expected to increase in stock distribution and/or productivity as a result of climate change trends.

The economies of communities reliant on marine species vulnerable to climate change trends could be adversely affected. If the distribution of important fish stocks changes, it could affect where commercial and for-hire recreational fisheries are located. Furthermore, coastal communities with fishing businesses that have infrastructure near the shore could be adversely affected by sea level rise (Colburn et al. 2016; Rogers at al. 2019).

As they become operational, future offshore wind facilities would produce fewer GHG emissions than fossil fuel–powered generating facilities with similar capacities. This reduction in GHG emissions (or avoidance of increased GHG emissions from equivalent fossil fuel–powered energy production) would result in long-term beneficial impacts to fishing operations that target species adversely affected by climate change trends. However, given the global scale of GHG emissions, the benefits would be **negligible**. Section 3.4 describes the expected contribution of offshore wind to air emissions and climate change trends.

Light: Construction and O&M activities related to offshore wind energy development that introduce artificial lighting could result in behavioral responses from some target species, such as fish not biting at hooks or changing swim height. In turn, these responses could decrease the catch rates of target species. For any given offshore wind energy project, adverse lighting impacts on target species catch in commercial and for-hire recreational fisheries are expected to be localized **minor** to **moderate** adverse and long term. Details regarding potential lighting impacts to finfish and EFH are described in Section 3.13

New cable emplacement/maintenance and EMF: Under the No Action Alternative, approximately 13,469 miles of offshore export and IACs could be installed along the U.S. East Coast to support future offshore wind energy projects (see Appendix E3). To the fullest extent possible, future offshore wind energy projects would reduce the occurrence of accidental snagging of fishing gear by burying all cables beneath the seafloor. BOEM (2018) notes that the standard commercial practice is to bury submarine cables 4 to 6 feet deep in waters shallower than 6,562 feet to protect them from external aggression hazards, such as fishing gear and anchors. Therefore, the impact of buried submarine cables to commercial fisheries and for-hire recreational fishing through entanglement or gear loss or damage is expected to be long term **moderate** adverse.

In areas where seafloor conditions or other factors might not allow for cable burial, other methods of cable protection would be employed, such as articulated concrete mattresses or rock placement. Impacts of this transmission cable infrastructure to commercial fisheries and for-hire recreational fishing through entanglement or gear loss/damage and navigation hazards are discussed below under the presence of structures IPF.

Fishermen have raised concerns regarding the suspected behavioral impacts of EMF generated by submarine cables on target fish and invertebrates (BOEM 2018). In particular, there is concern that EMF could slow or deviate migratory species from their intended routes, with subsequent potential problems for populations if they do not reach essential feeding, spawning, or nursery grounds (Kirkpatrick et al. 2017). To date, however, effects on representative sensitive species indicate that although some marine species are observed to respond to EMF, the responses have not risen to the level at which critical impacts on marine organism behavior are reported (BOEM 2018) (see Sections 3.6 and 3.13). 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). Therefore, the impacts of EMF on commercial fisheries and for-hire recreational fishing are expected to be long term but **negligible** to **minor** adverse.

Noise: Construction and O&M activities related to offshore wind energy development that increase underwater noise could result in behavioral responses from some target species, such as fish not biting at hooks or changing swim height. In turn, these responses could decrease the catch rates of target species, thereby reducing revenue for commercial fishing and for-hire recreational fishing businesses. Some sources of noise, such as vessels and pile driving during project construction, could cause some target species to temporarily move away from the source and disperse to other areas. These species are expected to return to the area after the noise ends. Alteration of the ambient noise environment during construction and O&M activities could also result in reduced reproductive success for some species, which could negatively impact catch levels in the fisheries targeting those species. Details regarding potential noise impacts to finfish and EFH are described in Section 3.13; impacts to invertebrate resources are described in Section 3.6. For any given offshore wind energy project, all adverse noise impacts on target species catch in commercial and for-hire recreational fisheries are expected to be localized and short term during construction and long term during O&M. The intensity of impacts is anticipated to be **moderate** adverse.

Presence of structures: The presence of structures can lead to impacts on commercial fisheries and for-hire recreational fishing through reduced catch levels of target species and increased space-use conflicts that may result in navigation hazards, allisions, and gear loss/damage. With respect to offshore wind energy development, these impacts could arise from buoys, met towers, foundations, scour/cable protection, and transmission cable infrastructure. Under the assumptions in Appendix E3, future offshore wind energy projects under the No Action Alternative would include the installation of 3,088 WTG and OSS foundations. In addition, projects could install buoys and meteorological evaluation towers. BOEM anticipates that structures would be added intermittently over an assumed 10-year period and that they would remain until decommissioning of each facility is complete.

The installation of offshore components for offshore wind energy projects could temporarily restrict fishing vessel movement and thus transit and harvesting activities within lease areas and along offshore export cable corridors. To safeguard mariners from the hazards associated with installation of these offshore components, it is expected that the USCG would create safety zones around offshore wind energy project construction areas (BOEM 2018). Fishing vessels would be prohibited from entering these safety zones. When the safety zones are in effect, fishing vessels could either forfeit fishing revenue or relocate to other fishing locations and continue to earn revenue. However, vessels that chose to relocate could incur increased operating costs (e.g., additional fuel to arrive at more distant locations; additional crew compensation due to more days at sea, assuming pay is not based on a percentage of harvest earnings) and/or lower revenue (e.g., less-productive area or less-valuable species).

During construction of offshore wind energy projects, temporary or permanent habitat alterations could occur, but the impact of these alterations on invertebrate and fish populations would be **negligible** to **minor** adverse (see Sections 3.6 and 3.13). Construction activities that disturb the seafloor could result in the injury or mortality of sedentary species such as sea scallop and surfclam. Given that the area affected by seafloor disturbance would be a fraction of the available habitat, the impact to sedentary species habitat would not be measurably altered compared to the environmental baseline. Therefore, the number of individual organisms affected would also be limited. Moreover, the populations of these species are expected to recover quickly through migration and recolonization from adjacent undisturbed habitat. Therefore, the adverse impacts to fisheries that target these species would be short term or long term **negligible** to **minor**, depending on the species.

In addition, construction activities related to offshore wind energy development could overlap with the spawning habitat and/or spawning season of a number of species targeted by commercial and for-hire recreational fisheries, leading to potential short-term **negligible** to **moderate** adverse impacts to the productivity and recruitment success of these species (see Sections 3.6 and 3.13). Therefore, the adverse impact on the catch of commercial and for-hire recreational fisheries targeting affected species would be short term **negligible** to **moderate**, depending on the species. See also noise and light impacts to commercial fisheries and for-hire recreational fishing.

Once offshore components are installed, the presence of the WTG and OSS foundations and associated scour protection would convert existing sand or sand with mobile gravel habitat to hard bottom, which in turn would reduce the habitat for target species that prefer soft-bottom habitat (e.g., squid, summer flounder, and surfclam) and increase the habitat for target species that prefer hard-bottom habitat (e.g., lobster, striped bass, black sea bass, and cod) (see Sections 3.6 and 3.13). However, given the small footprint of the lease areas and offshore cable corridors, any localized adverse impacts on target species populations from habitat alteration would have a **negligible** to **moderate** effect on the catch of for-hire recreational and commercial fisheries depending on the species targeted.

Where WTG and OSS foundations and associated scour protection produce an artificial reef effect and attract finfish and invertebrates, the aggregation of species could increase the catch rates of some target species (Kirkpatrick et al. 2017). Smythe et al. (2021) found that the enhanced fishing experience created by the BIWF led to the establishment of new for-hire recreational fishing businesses and benefited existing ones. It is expected that the reef effect of the WTG foundations would have long-term **negligible** to **minor** beneficial impacts to for-hire recreational fishing, depending on the extent to which the foundations attract targeted species. Additionally, the presence of food or shelter associated with the structures could alter the migratory behaviors of some species. In particular, the potential for disruption of onshore to offshore migratory patterns of important species such as lobster and black sea bass has been identified as a topic of concern (see Sections 3.6 and 3.13). Overall, localized adverse or beneficial impacts on target species populations from habitat alteration would have a long-term **negligible** to **moderate** effect on the target species catch of for-hire recreational and commercial fisheries.

As discussed above, the USCG does not plan to create exclusionary zones around offshore wind facilities during their operations (BOEM 2018). However, WTGs and OSSs would be visually detectable at a considerable distance during the day and easily detected by vessels equipped with radar regardless of the time of day. As described in Chapter 2 under the Proposed Action, all structures would have appropriate markings and lighting in accordance with USCG and International Association of Marine Aids to

Navigation and Lighthouse Authorities guidelines, and NOAA would chart WTG locations and could include a physical or virtual AIS at each turbine. Some fishing vessels operating in or near offshore wind facilities could experience radar clutter and shadowing. As discussed in Section 3.16, the USCG has reviewed all available studies on radar interference and found that although these studies show that structures could have some effect upon radar, they do not render radar inoperable.

Notwithstanding these safety measures, some fishermen have commented that because of safety considerations, they would not enter an offshore wind array during inclement weather, especially during low-visibility events (Kirkpatrick et al. 2017). In addition, trawl and dredge vessel operators have expressed specific concerns about being unable to safely deploy gear and operate in a WEA given the size of the gear, the spacing between the WTGs, and the space required to safely navigate (BOEM 2021b). Navigating through the WEAs would not be as problematic for for-hire recreational fishing vessels, which tend to be smaller than commercial vessels and do not use large external fishing gear (other than hook and line) that makes maneuverability difficult. However, trolling for highly migratory species (e.g., bluefin tuna [*Thunnus thynnus*], or swordfish [*Xiphias gladius*]) could 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 (BOEM 2021b).

A potential effect of the presence of the offshore cables associated with offshore wind energy development is the entanglement and damage or loss of commercial and recreational fishing gear. Specifically, cable protection in the form of rock berms, concrete mattresses, fronded mattresses, and/or rock bags could cause a potential safety hazard should gear snag or hook on these seafloor structures. In addition, seafloor preparation prior to cable installation may relocate boulders and other obstructions that could cause gear damage or loss. Economic impacts to fishing operations associated with gear damage or loss include the costs of gear repair or replacement, together with the fishing revenue lost while gear is being repaired or replaced. Given that mobile fishing gear is actively pulled by a vessel over the seafloor, the chance of snagging this gear type on transmission cable infrastructure is greater than if—as in the case of fixed gear—the gear was set on the infrastructure or waves or currents pushed the gear into the infrastructure (BOEM 2021b).

Fishing vessel operators unwilling or unable to travel through areas where offshore wind facilities are located or to deploy fishing gear in those areas could find suitable alternative fishing locations and continue to earn revenue. This could result in increased operating costs (e.g., additional fuel to arrive at more distant locations; additional crew compensation due to more days at sea, assuming pay is not based on a percentage of harvest earnings) and/or lower revenue (e.g., fishing in a less-productive area or for a less-valuable species). However, if at times a fishery resource is only available within an offshore wind facility area, some fishermen, primarily those using mobile gear, could lose the revenue from that resource for the time the resource is inaccessible. These impacts could remain until decommissioning of each facility is complete, although the magnitude of the impacts would diminish over time if fishing practices adapt to the presence of structures.

An accurate assessment of the effects of planned offshore wind energy projects on the economic performance of commercial fisheries and for-hire recreational fishing in the GAA would depend on project-specific information that is unknown at this time, such as the actual location of offshore activities within lease areas and the arrangement of WTGs. However, it is possible to estimate the amount of commercial fishing revenue that would be “exposed” (i.e., potentially foregone) as a result of offshore wind energy development. Estimates of revenue exposure quantify the value of fishing that occurs in the footprint areas of individual offshore wind farms based on historical spatial catch data. Therefore, these estimates represent the fishing revenue that would be foregone if fishing vessel operators opt to no longer fish in these areas and cannot capture that revenue in a different location. Revenue exposure estimates should not be interpreted as measures of actual economic impact. Actual economic impact would depend on many factors—foremost, the potential for continued fishing to occur within the footprint of the wind farm, together with the ecological impact on target species residing within these lease areas. Economic impacts also depend on a vessel's ability to adapt to changing where it fishes. For example, if alternative fishing grounds are available nearby and could be fished at no additional cost, the economic impact would be lower. In addition, it is important to note that there could be cultural and traditional values to fishermen from fishing in certain areas that go beyond expected profit. For example, some fishermen could 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 could contribute to the fishermen's sense of safety. Given this, changes in where fishermen fish may affect social relationships and cultural identity and therefore the wellbeing of individuals and communities. Impacts on these social and cultural values are not quantifiable but are qualitatively considered when assessing the impacts of the No Action Alternative.

Also of note when calculating revenue exposure are the species with limited existing datasets (BOEM 2022). As described in Section 3.9.1, these data-limited species include American lobster, Jonah crab, and highly migratory species. In addition, the landings of fishing vessels with only state permits are not included in the federal VTR dataset. Consequently, this analysis may not fully represent the actual revenue exposure for some fisheries.

Table 3.9-24 shows the estimated annual commercial fishing revenue exposed to offshore wind energy development in the Mid-Atlantic and New England regions under the No Action Alternative by FMP fishery. The table includes the revenue at risk from the 1) Coastal Virginia Offshore Wind, which has been completed; 2) Vineyard Wind 1 and SFWF, which are being constructed; and 3) proposed offshore wind farms on the Atlantic Coast for which leases have been granted, with the exception of RWF. Fisheries data for BIWF were unavailable. Annual revenue-at-risk estimates are based on 2008–2019 data from NMFS (2021b). The average annual revenue by FMP for each offshore wind energy project is assigned to the construction year based on the timeline and project phasing set forth in Table E-1 of Appendix E. A detailed explanation of the methodology used to develop Table 3.9-24 is found in the Commercial Fisheries section of Appendix G.

The largest impacts in terms of exposed revenue are expected to be in the Northeast Skate Complex, Atlantic Sea Scallop, and Surfclam/Ocean Quahog FMP fisheries. The total average annual exposed revenue from 2022 to 2030 represents approximately 2% of the average annual revenue of all FMP and non-FMP fisheries in the Mid-Atlantic and New England regions from 2008 to 2019 (see Table 3.9-1). The maximum exposed revenue—which is projected to occur as early as 2029 when construction on the last of the foreseeable projects could begin—represents about 3.6% of the average annual revenue of all FMP and non-FMP fisheries in the regions. In general, fisheries do not have high relative revenue intensity within the lease areas compared with nearby waters because lease areas were chosen to reduce potential use conflicts between the wind energy industry and fishermen (Ecology and Environment, Inc. 2013).

Table 3.9-24. Estimated Annual Commercial Fishing Revenue Exposed to Offshore Wind Energy Development in the Mid-Atlantic and New England Regions under the No Action Alternative by FMP Fishery (2022–2030)

FMP Fishery ($1,000s)	2022	2023	2024	2025	2026	2027	2028	2029	2030
American Lobster	$0.0	$152.2	$197.8	$270.7	$427.1	$526.7	$581.4	$636.0	$636.0
Atlantic Herring	–	$29.5	$61.6	$81.0	$133.3	$174.8	$207.2	$239.5	$239.5
Bluefish	$0.0	$4.1	$6.8	$11.0	$14.5	$16.5	$18.0	$19.5	$19.5
Highly Migratory Species	$0.0	$0.1	$0.2	$0.7	$0.9	$1.2	$1.4	$1.6	$1.6
Jonah Crab	$0.0	$41.1	$78.6	$224.4	$311.0	$335.3	$355.8	$376.4	$376.4
Mackerel/Squid/ Butterfish	$0.1	$310.8	$553.8	$756.5	$1,122.6	$1,275.9	$1,409.7	$1,543.6	$1,543.6
Monkfish	$0.0	$355.1	$428.3	$535.4	$699.8	$803.6	$886.1	$968.6	$968.6
Northeast Multispecies (large-mesh)	–	$150.3	$164.9	$182.6	$231.8	$254.2	$268.4	$282.7	$282.7
Northeast Multispecies (small-mesh)	$0.0	$97.5	$139.4	$229.5	$320.4	$348.8	$365.6	$382.5	$382.5
Atlantic Sea Scallop	$0.0	$357.6	$2,601.8	$2,876.4	$7,819.6	$12,686.9	$17,527.1	$22,367.4	$22,367.4
Northeast Skate Complex	–	$184.5	$223.6	$284.3	$379.4	$430.7	$462.9	$495.1	$495.1
Spiny Dogfish	–	$13.5	$20.7	$25.5	$31.5	$35.6	$37.7	$39.8	$39.8
Summer Flounder/Scup/ Black Sea Bass	$0.1	$222.5	$392.3	$592.1	$863.4	$1,049.3	$1,214.2	$1,379.2	$1,379.2
Other FMPs, non-disclosed species, and non-FMP fisheries*	$0.4	$656.3	$819.2	$1,015.9	$1,616.2	$2,029.8	$2,411.6	$2,793.4	$2,793.4
All revenues of federally permitted vessels	$0.7	$2,711.1	$5,867.5	$7,933.8	$15,239.3	$21,641.1	$27,823.5	$34,005.9	$34,005.9

Source: Developed using construction schedule data from Table E-1 in Appendix E and fishing revenue data from NMFS (2022a).

Notes: Exposed revenue estimates are based on commercial fishery revenues in Atlantic offshore wind energy lease areas exclusive of the Revolution Wind Lease Area. Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator and is estimated based on the average annual revenue by FMP from 2008 through 2019.

The federal VTR data used to estimate revenue exposure provide a broad census of fishing activity that encompasses most of the commercial fisheries in the Mid-Atlantic and New England regions. However, there are species with limited existing datasets for calculating revenue exposure, including American lobster, Jonah crab, and highly migratory species. In addition, the landings of fishing vessels with only state permits are not included in the federal VTR dataset. Consequently, this analysis may not fully represent the actual revenue exposure for some fisheries.

"–" indicates the value is zero; "$0" indicates the value is positive but less than $500.

* Includes all species not assigned to an FMP, as listed in the table.

With respect to impacts to individual fishing operations, NMFS (2022a) determined for each federally permitted commercial fishing vessel that fished in New England/Mid-Atlantic offshore wind energy development lease areas the percentage of the vessel's total fishing revenue from 2008 through 2019. It is estimated that over that period, only 0.9% of the vessels that fished in one or more of the lease areas generated more than 50% of their total fishing revenue for the year from one or more of the areas. According to the data presented, in each lease area, there were one or more vessels that earned a substantial (> 5%) portion of their revenue from fishing in the area. Some vessels derived more than half of their revenue from fishing in a particular lease area. However, 75% of the vessels fishing in any given lease area derived less than 0.9% of their total revenue from the area.

For those fishing vessels that derive a large percentage of their total revenue from areas where offshore wind facilities would be located, that choose to avoid these areas once the facilities become operational, and that are unable to find suitable alternative fishing locations, the adverse impacts of the presence of structures would be long term **major**. As discussed above, the displacement of fishermen from their customary fishing grounds can adversely affect the social wellbeing of individuals and communities as well as the profitability of fishing operations. However, it is expected that most fishing vessels would only have to adjust somewhat to account for disruptions due to the presence of structures. A majority derive a small percentage of their total revenue from any one lease area or would be able to relocate to other fishing locations. In addition, the impacts of offshore wind energy facilities could include long-term **minor** beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect. Therefore, BOEM expects that the impacts to commercial fisheries and for-hire recreational fishing resulting from the presence of structure would be long term **negligible** to **major** adverse, depending on the fishery and fishing operation. If BOEM's recommendations related to project siting, design, navigation, access, safety measures, and financial compensation are implemented across all offshore wind energy projects (see BOEM 2022), adverse impacts on commercial fisheries due to the presence of structures could be reduced.

The offshore structures associated with offshore wind energy development could also affect commercial fisheries and for-hire recreational fishing by preventing or hampering NMFS's ongoing scientific surveys on which fishery management measures are based. If NMFS's scientific survey methodologies are not adapted to sample within wind energy facilities, there could be increased uncertainty in scientific survey results, which would increase uncertainty in stock assessments and quota setting processes. This increased uncertainty, in turn, could result in more conservative catch quotas and/or more restrictive effort management measures for commercial and recreational fisheries (BOEM 2021b). Additional information on impacts to NMFS scientific research and protected species surveys is provided in Section 3.17.

Vessel traffic: Construction of offshore wind energy projects would require staging and installation vessels, including crew transfer, dredging, cable lay, pile driving, survey vessels, and potentially feeder lift barges and heavy lift barges. A more limited number of vessels would also be required for routine maintenance during the O&M phase. The additional vessel volume could cause vessel traffic congestion, difficulties with navigating, and an increased risk for collisions. These potential adverse impacts could cause some fishing vessel operators to change routes (see Section 3.16).

Once offshore wind energy projects are completed, some commercial fishermen could avoid the lease areas if large numbers of recreational fishermen are drawn to the areas by the prospect of higher catches. As discussed above, WTG and OSS foundations and associated scour protection could produce an artificial reef effect, potentially increasing fish and invertebrate abundance within a facility's footprint. According to ten Brink and Dalton (2018), the influx of recreational fishermen into the BIWF caused some commercial fishermen to cease fishing in the area because of vessel congestion and gear conflict concerns. If these concerns cause commercial fishermen to shift their fishing effort to areas not routinely fished, conflict with existing users could increase as other areas are encroached. In general, the potential for conflict among commercial fishermen due to fishing displacement could be higher in a fixed gear fishery with regulations that restrict where individual permit holders in the fishery can fish, such as the lobster fishery. However, the potential for vessel congestion and gear conflict could also increase if mobile species targeted by commercial fishermen, such as Atlantic herring, Atlantic mackerel (*Scomber scombrus*), squid species, tuna species, and groundfish species, are attracted to offshore wind energy facilities by the artificial reef effect, and fishermen targeting these species concentrate their fishing effort in offshore wind farm lease areas as a result.

Overall, the vessel traffic effects on commercial fisheries and for-hire recreational fishing are expected to be short term **moderate** adverse during construction and long term **minor** to moderate adverse during O&M.

Onshore Activities and Facilities

<u>Port utilization</u>: Offshore wind energy projects would require vessels for staging and installation during construction and for routine maintenance during operations. This additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to, and higher costs for, high-demand port services (e.g., fueling and provisioning) by existing port users, including commercial fishing vessels and for-hire recreational fishing vessels. These potential adverse impacts could cause some fishing vessel operators to use an alternative port (see Section 3.16 and Section 3.11). As fishing vessels shift the location of their landings and shoreside service activities, the could result in economic losses and a decline in fisheries-related onshore infrastructure in some ports but could result in economic gains and enhanced infrastructure in others.

However, regardless of whether offshore wind energy development occurs, most ports are going through continual upgrades and maintenance to ensure that they can receive projected future volumes of vessels. Moreover, state and local agencies would be responsible for minimizing the potential adverse impacts of additional port utilization by managing traffic to ensure continued access to port facilities (see Section 3.16). In addition, the use of multiple ports to support offshore wind energy project development would reduce the related congestion impacts in any one port. Therefore, port utilization impacts to commercial fisheries and for-hire recreational fishing are expected to be localized long term **minor** to **moderate** adverse.

3.9.2.2.3 Conclusions

BOEM anticipates that reasonably foreseeable offshore wind activities would have long-term **moderate** to **major** adverse impacts on commercial fisheries and **minor** to **moderate** adverse impacts on for-hire recreational fishing in the GAA. These impacts would be primarily due to the increased presence of offshore structures (foundations and cable protection measures) that could reduce fishing access and increase the risk of fishing gear damage or loss, and prevent or hamper continued research surveys. The extent of adverse impacts would vary by fishery and fishing operation due to differences in target species, gear type, and the predominant location of fishing activity. The impacts could also include long-term **minor** beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect.

3.9.2.3 Alternative B: Impacts of the Proposed Action on Commercial Fisheries and For-Hire Recreational Fishing

3.9.2.3.1 Construction and Installation

Offshore Activities and Facilities

Accidental releases and discharges: As discussed in the No Action Alternative (see Section 3.9.2.2), compliance with regulatory requirements would minimize releases of water quality contaminants and trash or debris. Additionally, training and awareness of EPMs proposed for waste management and reduction of marine debris would be required of Project personnel (see Table F-1 in Appendix F). Accidental spill or release of oils or other hazardous materials offshore would be managed through the oil spill response plan (OSRP). Therefore, during Project construction, the impacts of accidental releases and discharges on target species catch in commercial and for-hire recreational fishing are expected to be localized **negligible** adverse and short term or long term depending on the type and volume of material released. Details regarding potential water quality impacts to finfish and invertebrates are described in Section 3.6 and Section 3.13.

Anchoring: Potential impacts from anchoring vessels used during Project construction would be the same as the No Action Alternative (see Section 3.9.2.2): short term **negligible** to **minor** adverse. Details regarding potential navigation impacts to commercial and for-hire recreational fishing vessels are described in Section 3.16.

Light: Project construction activities that introduce artificial lighting could result in behavioral responses from some target species (see Sections 3.6 and 3.13). In turn, these responses could decrease the catch rates of target species, thereby reducing revenue for commercial fishing and for-hire recreational fishing businesses. Project EPMs include construction vessel light shielding to minimize artificial lighting effects on the environment (see Table F-1 in Appendix F). Project-related lighting impacts on target species catch in commercial and for-hire recreational fisheries are expected to be localized, **negligible** to **minor** adverse, and short term.

New cable emplacement/maintenance: The installation of the offshore export and IACs could temporarily restrict vessel movement and thus transit and harvesting activities in the Lease Area and along the RWEC. These impacts of new cable emplacement to commercial fisheries and for-hire recreational fishing are discussed below under the presence of structures IPF.

Noise: As discussed in the No Action Alternative, Project construction activities that increase underwater noise could cause behavioral responses from some marine species or could result in reduced reproductive success for some species. These impacts, in turn, could negatively impact catch levels in the fisheries targeting those species. According to Revolution Wind, a ramp-up or soft start would be used at the beginning of each pile segment during impact pile driving and/or vibratory pile driving to provide additional protection to mobile species in the vicinity by allowing them to vacate the area before pile-driving activities begin (see Table F-1 in Appendix F). In addition, BOEM would require an adaptive management approach that would require the applicant to prepare an acoustic monitoring plan and, based on the monitoring, require the applicant to avoid activities that would disrupt spawning aggregations of Atlantic cod (*Gadus morhua*). If implemented, a restriction on pile-driving activity to times outside the Atlantic cod spawning season would minimize adverse impacts on cod spawning and likely avoid broader population-level effects (see Section 3.13). Therefore, Project-related construction noise is expected to have a localized **minor** to **moderate** adverse impact on the target species catch of commercial fisheries and for-hire recreational fishing.

Presence of structures: As discussed in the No Action Alternative, the installation of offshore Project components, including the WTGs and export cables, could temporarily restrict vessel movement and thus transit and harvesting activities in the Lease Area and along the RWEC. Construction safety zones implementation dates are pending and would depend on the Project schedule and duration of the expected construction phase. To allow fishing vessels to alter their plans to avoid impacted areas, Revolution Wind would publicize safety zones in advance via a local notice to mariners and would communicate in advance where and when construction activities are scheduled (see Table F-1 in Appendix F).

In addition, if the fishing effort is shifted to areas not routinely fished, conflict with existing users could increase as other areas are encroached. The competition would be higher for fishermen engaged in fisheries with regulations that constrain where fishermen can fish, such as the lobster fishery. The potential for conflict due to fishing displacement is lower among fishermen targeting mobile species such as Atlantic herring, Atlantic mackerel, squid species, tuna species, and groundfish species. In a given year, however, it is possible that the center of the exploitable biomass, or the portion of a fish population available to fishing gear, of one or more of these species would occur within the Lease Area or along the RWEC during construction. During these occurrences, fishermen could be adversely impacted because of restricted access to the available fish population within the Project construction area. Given the small size of the offshore areas affected during construction, the likelihood of this co-occurrence in time and space would be low, as would be the likelihood of increased conflict and competition from a temporary displacement of fishing activities.

It is difficult to predict the ability of fishing operations displaced by Project construction activities to locate alternative fishing grounds that would allow them to maintain revenue targets while continuing to minimize costs. However, the available data suggest the presence of alternative productive fishing grounds near the Lease Area and RWEC. As shown in the revenue intensity figures in Appendix G (Figures G-CF1 through G-CF13), the revenue intensity levels for many of the FMP fisheries in large expanses of ocean within 20 nm of the Lease Area and RWEC corridor are comparable to or higher than those within the two areas.

Based on 2008–2019 NMFS data, Table G-CF6 through Table G-CF9 in Appendix G show the estimated number of vessels and vessel trips that would be affected by Project construction in the Lease Area and along the RWEC under the Proposed Action (NMFS 2021a, 2022b). The largest impacts in terms of the number of vessels active in the Lease Area and along the RWEC as a percentage of total fishing effort in the RFA would be in the Jonah Crab (52%), Northeast Multispecies (small-mesh) (47%), and Mackerel/Squid/Butterfish (43%) FMP fisheries. The species most affected in terms of number of vessels as a percentage of total effort in the RFA would be rock crab (56%), butterfish (53%), Jonah crab (52%), and red hake (52%). Midwater trawl (68%) and lobster pot gear (53%) would be the gear types most affected. With respect to ports, the largest impacts would be in Little Compton (93%), Fall River (92%), and Chilmark/Menemsha (88%).

It is possible to estimate the amount of commercial fishing revenue that would be exposed under the Proposed Action as a result of construction activities in the Lease Area and along the offshore RWEC. As discussed in Section 3.9.2.2, estimates of revenue exposure represent the fishing revenue that would be foregone if fishing vessel operators cannot capture that revenue in a different location. Based on commercial fishing revenue data averaged over the 2008–2019 period, Table 3.9-25 and Table 3.9-26 show the annual revenue at risk in the Lease Area and along the RWEC during each year of the 2-year (2023–2024) Project construction phase by FMP fishery and gear type, respectively. Most of the WTG and RWEC installation is expected in year 2 (2024). The largest impacts in terms of exposed revenue as a percentage of total revenue in the RFA would be in the Spiny Dogfish, American Lobster, Atlantic Herring, and Northeast Skate Complex FMP fisheries. The amount of commercial fishing revenue that would be exposed across all FMP and non-FMP fisheries is estimated to be $1.42 million. The annual exposed revenue represents 0.15% of the average annual revenue for all FMP and non-FMP fisheries in the Mid-Atlantic and New England regions and 0.99% of the average annual revenue for all FMP and non-FMP fisheries in the RFA. Midwater trawl, all other, and pot gear would be the gear types most affected in terms of exposed revenue as a percentage of total revenue in the RFA.

Table 3.9-25. Estimated Annual Commercial Fishing Revenue Exposed in the Lease Area and along the Revolution Wind Export Cable by FMP Fishery under the Proposed Action

FMP Fishery	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue at Risk as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions	Average Annual Revenue at Risk as a Percentage of Total Revenue in the RFA
American Lobster	$507.7	$283.8	0.30%	3.64%
Atlantic Herring	$273.5	$102.9	0.40%	3.44%
Bluefish	$17.2	$8.7	0.68%	1.50%
Highly Migratory Species	$6.9	$2.2	0.10%	1.00%
Jonah Crab	$40.7	$23.2	0.24%	0.39%
Mackerel/Squid/Butterfish	$324.4	$145.3	0.28%	0.94%
Monkfish	$210.0	$109.9	0.53%	1.46%
Northeast Multispecies (large-mesh)	$117.0	$52.6	0.07%	2.20%
Northeast Multispecies (small-mesh)	$193.3	$74.3	0.66%	2.63%
Atlantic Sea Scallop	$409.9	$157.1	0.03%	0.32%
Northeast Skate Complex	$175.9	$110.7	1.49%	3.09%
Spiny Dogfish	$35.7	$15.7	0.53%	6.45%

FMP Fishery	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue at Risk as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions	Average Annual Revenue at Risk as a Percentage of Total Revenue in the RFA
Summer Flounder/Scup/Black Sea Bass	$133.5	$84.3	0.21%	0.77%
Other FMPs, non-disclosed species, and non-FMP fisheries	$574.6	$248.0	N/A	N/A
Total	$1,707.8	$1,418.8	0.15%	0.99%

Source: Developed using 2008-2019 data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows including the Total row.

The "Other FMPs, non-disclosed species, and non-FMP fisheries" category includes revenue from three FMP fisheries: Surfclam/Ocean Quahog, Red Crab, and River Herring. It also includes a) revenue from species in FMP fisheries for which data could not be disclosed due to confidentiality restrictions and b) revenue earned by federally permitted vessels operating in fisheries that are not federally managed.

The federal VTR data used to estimate revenue exposure provide a broad census of fishing activity that encompasses most of the commercial fisheries in the Mid-Atlantic and New England regions. However, there are species with limited existing datasets for calculating revenue exposure, including American lobster, Jonah crab, and highly migratory species. In addition, the landings of fishing vessels with only state permits are not included in the federal VTR dataset. Consequently, this analysis may not fully represent the actual revenue exposure for some fisheries.

Table 3.9-26. Estimated Annual Commercial Fishing Revenue Exposed in the Lease Area and along the Revolution Wind Export Cable by Gear under the Proposed Action

Gear Type	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue at Risk as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions	Average Annual Revenue at Risk as a Percentage of Total Revenue in the RFA
Dredge-clam	*$399.9*	*$121.1*	*0.20%*	*0.58%*
Dredge-scallop	$417.6	$157.7	0.03%	0.33%
Gillnet-sink	$291.6	$197.4	0.66%	2.05%
Handline	$15.7	$3.7	0.08%	0.27%
Pot-other	$531.2	$345.3	0.30%	2.15%
Trawl-bottom	$658.9	$492.1	0.26%	1.14%
Trawl-midwater	*$191.8*	*$98.1*	*0.52%*	*4.18%*

Gear Type	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue at Risk as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions	Average Annual Revenue at Risk as a Percentage of Total Revenue in the RFA
All other gear*	$288.3	$70.1	0.15%	2.63%
Total	$1,707.8	$1,485.6	0.16%	1.03%

Source: Developed using 2008-2019 data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows including the Total row.

Gear types shown in *italics* indicate that fewer than 12 years but more than 4 years of data were used to calculate the estimates. Otherwise, estimates are based on 12 years of data.

The federal VTR data used to estimate revenue exposure provide a broad census of fishing activity that encompasses most of the commercial fisheries in the Mid-Atlantic and New England regions. However, there are species with limited existing datasets for calculating revenue exposure, including American lobster, Jonah crab, and highly migratory species. In addition, the landings of fishing vessels with only state permits are not included in the federal VTR dataset. Consequently, this analysis may not fully represent the actual revenue exposure for some fisheries.

* Includes revenue from federally permitted vessels using longline gear, seine gear, other gillnet gear, and unspecified gear, as well as listed gear for years when they were not disclosed.

Table 3.9-27 shows the annual revenue at risk in the Lease Area and along the RWEC during the Project construction phase by port. The average annual revenue at risk as a percentage of total revenue was calculated by taking the revenue in a particular port from vessels fishing within the Lease Area and export cable corridor and dividing it by the total landings from the Mid-Atlantic and New England regions or RFA for that same port. The largest impacts in terms of exposed revenue as a percentage of total commercial fishing revenue in the RFA would be in the ports of Little Compton (7.4%), Westport (5.7%), and Chilmark/Menemsha (4.1%). As shown in Table 3.9-4, the communities in which these ports are located have a low to medium presence of commercial fishing activities.

Table 3.9-27. Estimated Annual Commercial Fishing Revenue Exposed in the Lease Area and along the RWEC by Port under the Proposed Action

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue at Risk as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions	Average Annual Revenue at Risk as a Percentage of Total Revenue in the RFA
Beaufort, NC	*$5.4*	*$2.6*	*0.10%*	*0.31%*
Chilmark/Menemsha, MA	$29.1	$17.1	3.62%	4.06%
Fairhaven, MA	*$29.8*	*$15.5*	*0.14%*	*1.07%*
Fall River, MA	*$18.2*	*$9.2*	*0.81%*	*2.07%*
Hampton, VA	*$8.2*	*$3.9*	*0.03%*	*0.25%*
Little Compton, RI	$219.9	$143.2	7.19%	7.38%
Montauk, NY	$42.8	$18.8	0.10%	0.16%

Port and State	Peak Annual Revenue ($1,000s)	Average Annual Revenue ($1,000s)	Average Annual Revenue at Risk as a Percentage of Total Revenue in the Mid-Atlantic and New England Regions	Average Annual Revenue at Risk as a Percentage of Total Revenue in the RFA
New Bedford, MA	$596.2	$369.4	0.10%	0.76%
New London, CT	*$22.8*	*$10.4*	*0.16%*	*0.39%*
Newport News, VA	*$16.2*	*$4.1*	*0.01%*	*0.24%*
Newport, RI	$194.1	$109.0	1.22%	3.78%
Point Judith, RI	$746.5	$574.2	1.25%	2.08%
Point Pleasant Beach, NJ	*$16.8*	*$4.8*	*0.02%*	*0.06%*
Stonington, CT	$21.5	$7.5	0.07%	0.24%
Tiverton, RI	*$17.7*	*$7.2*	*0.63%*	*1.11%*
Westport, MA	$121.0	$67.1	5.14%	5.74%
Revenues by Port State‡				
All Connecticut ports	$44.3	$13.6	0.08%	0.23%
All Massachusetts ports	$695.6	$474.4	0.10%	0.84%
All New Jersey ports	*$16.8*	*$6.8*	*0.00%*	*0.04%*
All New York ports	$42.8	$18.8	0.06%	0.10%
All Rhode Island ports	*$997.9*	*$833.9*	*1.21%*	*2.47%*
Ports in all other states	*$24.3*	*$8.4*	*0.01%*	*0.19%*
Port data withheld for confidentiality‡	$145.3	$68.6	0.15%	1.23%
Total	**$1,707.8**	**$1,424.6**	**0.15%**	**0.99%**

Source: Developed using 2008-2019 data from NMFS (2021a, 2022b).

Notes: Revenue is adjusted for inflation to 2019 dollars using the GDP Implicit Price Deflator. Peak annual revenue is calculated independently for all rows including the Total row.

MA = Massachusetts, MD = Maryland, NC = North Carolina, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia.

Ports shown in *italics* indicate that fewer than 12 years but more than 4 years of data were used to calculate the estimates. Otherwise, estimates are based on 12 years of data.

The federal VTR data used to estimate revenue exposure provide a broad census of fishing activity that encompasses most of the commercial fisheries in the Mid-Atlantic and New England regions. However, there are species with limited existing datasets for calculating revenue exposure, including American lobster, Jonah crab, and highly migratory species. In addition, the landings of fishing vessels with only state permits are not included in the federal VTR dataset. Consequently, this analysis may not fully represent the actual revenue exposure for some fisheries.

‡ Revenues by Port State include all of the revenues by the ports listed above, as well as revenues of other ports within the state that were reported by NMFS, but which had 4 or fewer years of data and were not included in the table.

‡ Includes data for all ports that were withheld by NMFS to protect the confidentiality of individual vessels and/or buyers.

Revenue exposure estimates should not be interpreted as measures of actual economic impact. Actual economic impact would depend on many factors—foremost, the ability of vessels to adapt to changing where they fish, together with the ecological impact on target species residing within these lease areas (see discussion of potential impacts to target species catch below). Fishing vessel operators could find suitable alternative fishing locations and continue to earn revenue. However, as noted above, this shift in fishing effort could result in increased operating costs and/or lower revenue. In addition, economic impacts would also depend on the timing of construction activities. Specifically, the time of year during which construction occurs could affect access to fishing areas and availability of targeted fish in the area, which, in turn, could affect catch volumes and fishing revenue.

As described under the No Action Alternative, there could be cultural and traditional values to fishermen from fishing in certain areas that go beyond expected profit. For instance, some fishermen could gain utility from being able to fish in locations that are known to them and also fished by their peers, and the presence of other boats in the area can contribute to the fishermen's sense of safety. Given this, changes in where fishermen fish may affect social relationships and cultural identity and therefore the wellbeing of individuals and communities. Impacts on these social and cultural values are not quantifiable but are qualitatively considered when assessing the impacts of the Proposed Action.

The amount of fishing activity that could be affected during Project construction as a result of reduced fishing access is a small fraction of the amount of fishing activity in the Mid-Atlantic and New England regions as a whole. As described above, the annual exposed revenue represents approximately 0.15% of the average annual revenue for all FMP and non-FMP fisheries in the Mid-Atlantic and New England regions from 2008 through 2019, and approximately 0.99% of the average annual revenue for all FMP and non-FMP fisheries in the RFA. Nevertheless, some individual operators of commercial fishing or for-hire recreational fishing businesses could experience adverse economic impacts as a result of reduced fishing access.

As discussed in Section 3.9.1, an average of 289 vessels per year fished in the Lease Area from 2008 through 2019. A small number of fishing vessels historically derived a large percentage of their total fishing revenue from the area. For example, the vessel with the greatest dependence on the Lease Area derived 38% of its total revenue over the 2008–2019 period from the area. If these fishing vessels are unable to find suitable alternative fishing locations when safety zones are in effect during Project construction, the adverse impacts would be temporarily **major**. The displacement of fishermen from their customary fishing grounds can adversely affect the social wellbeing of individuals and communities as well as the profitability of fishing operations. However, three-quarters of the vessels that fished in the Lease Area derived 0.88% or less of their total annual revenue from the area. Moreover, some fishing vessels would likely be able to relocate to other fishing locations when safety zones are in effect and would continue to earn revenue. Therefore, most of the fishing vessels are expected to experience temporary **negligible** to **moderate** adverse impacts as a result of the establishment of safety zones during Project construction.

It is estimated that during Project construction, the revenue exposure for any given port would not exceed 8% of its total revenue from the Mid-Atlantic and New England regions or from the RFA (see Table 3.9-27). Considering this moderate revenue at risk across ports, together with the small number of vessels that depend heavily on the Lease Area and the ability of vessels to adjust transit and fishing locations to avoid conflicts with construction activities, the impacts to other fishing industry sectors, including seafood processors and distributors and shoreside support services, are expected to be temporary **minor** to **moderate** adverse.

In addition, as described in Table F-1 in Appendix F, Revolution Wind is committed to establishing a Direct Compensation Program for impacted fishermen. Revolution Wind would base the direct compensation program on findings from two separate Coastal Zone Management Act (CZMA) consistency reviews conducted by the states of Rhode Island and Massachusetts and resulting mitigation agreements. The direct compensation programs, which are part of the mitigation agreements for the states of Rhode Island and Massachusetts, would address impacts to commercial fishing operations and for-hire recreational fishing operations. Understanding there may be impacts outside of Rhode Island and Massachusetts, Revolution Wind is committed to advancing and adhering to principles set forth by the nine-state initiative as well as ideals laid out in the BOEM guidance. In addition to the direct compensation programs created during the CZMA process, Revolution Wind would create or contribute to Coastal Community Funds in Rhode Island and Massachusetts. The contribution amounts would be determined during the CZMA process. The Coastal Community Funds would be grant-making entities, unrelated to Revolution Wind, and open to all fishing interests, including private recreational angling and onshore support businesses. Also described in Table F-1 in Appendix F is a fishing gear conflict prevention and claim procedure to be used when interactions between the fishing industries and Project activities or infrastructure cause undue interference with fishing gear. The use of this procedure for qualifying gear interactions that could occur during Project construction or O&M is considered part of the Proposed Action and would reduce any adverse impacts to commercial or for-hire recreational fishing operations due to fishing gear loss or damage.

During Project construction, temporary or permanent habitat alterations could occur, but the impact of these alterations on invertebrate and fish populations would be **negligible** to **minor** adverse (see Sections 3.6 and 3.13). Construction activities that disturb the seafloor could result in the injury or mortality of sedentary species such as sea scallop and surfclam. Given that the area affected by seafloor disturbance would be a fraction of the available habitat, the impact to sedentary species habitat would not be measurably altered compared to the environmental baseline. Therefore, the number of individual organisms affected would also be limited. Moreover, the populations of these species are expected to recover quickly through migration and recolonization from adjacent, undisturbed habitat. Therefore, the adverse impacts to fisheries that target these species would be short term or long term **negligible** to **minor**, depending on the species.

Construction activities could overlap with the spawning habitat and/or spawning season of a number of target species, leading to potential short-term **negligible** to **moderate** adverse impacts to the productivity and recruitment success of these species (see Sections 3.6 and 3.13). Therefore, the adverse impact on the catch of commercial and for-hire recreational fisheries targeting these affected species would be short term **negligible** to **moderate**, depending on the species. See also noise and light impacts to commercial fisheries and for-hire recreational fishing.

As discussed in the No Action Alternative (see Section 3.9.1.1), the offshore structures associated with offshore wind energy development could also affect commercial fisheries and for-hire recreational fishing by preventing or hampering NMFS's ongoing scientific surveys on which fishery management measures are based. Additional information on impacts to NMFS's scientific research and protected species surveys is provided in Section 3.17.

Vessel traffic: Construction of the Project would involve the same types of vessels and vessel traffic as described in the No Action Alternative (see Section 3.9.2.2). The additional vessel volume in construction ports could cause vessel traffic congestion, difficulties with navigating, and an increased risk for collisions (see Section 3.16 and Section 3.11). However, the Project-related increase in vessel traffic would be nominal when compared to existing vessel operations within the GAA (VHB 2023). In addition, Revolution Wind would implement a comprehensive communication plan during offshore construction to inform all mariners, including commercial and recreational fishermen, of construction activities and vessel movements. Communication would be facilitated through a fisheries liaison, Project website, and public notices to mariners and vessel float plans (in coordination with USCG) (see Table F-1 in Appendix F). As a result, the adverse impact on commercial fisheries and for-hire recreational fishing would be temporary and **moderate**.

Onshore Activities and Facilities

Port utilization: Several port facilities located in New York, Rhode Island, Massachusetts, and Connecticut are considered for offshore Project construction, staging, and fabrication, as well as crew transfer and logistics support. Although final port selection has not been determined at this time, the list of affected commercial ports could include ports used by commercial fishing vessels and for-hire recreational fishing vessels. For example, fishing ports that could be used during construction and installation, O&M, or decommissioning of the Lease Area or RWEC include Montauk, New London, Point Judith, and New Bedford (VHB 2023). During the facility design report phase, Revolution Wind would finalize commercial ports to be used to support offshore installation activities for the Lease Area and RWEC.

Vessels for staging and installation during construction would add traffic to port facilities. The additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to high-demand port services (e.g., fueling and provisioning) by existing port users, including commercial fishing vessels and for-hire recreational fishing vessels. These potential adverse impacts could cause some fishing vessel operators to use an alternative port (see Section 3.16 and Section 3.11). As fishing vessels shift the location of their landings and shoreside service activities, the result could be economic losses and a decline in fisheries-related onshore infrastructure in some ports but could be economic gains and enhanced infrastructure in others.

As noted above, Revolution Wind would implement a comprehensive communication plan during offshore construction that would reduce the adverse impacts on other users of ports supporting Project construction. As a result, the adverse impact on commercial fisheries and for-hire recreational fishing would be short term **minor** to **moderate**.

3.9.2.3.2 Operations and Maintenance and Conceptual Decommissioning

This section focuses on the impacts to commercial fisheries and for-hire recreational fishing during Project O&M. Decommissioning of the Lease Area and RWEC would have similar impacts on commercial fisheries and for-hire recreational fishing as construction. Within 2 years of cancellation, expiration, or other termination of the lease, Revolution Wind would remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the Lease Area (VHB 2023). Any cut and cleared cables would typically have the exposed ends weighted with clump anchors so that the cables cannot be snagged by fishing gear. Removal of structures that produce an artificial reef effect would result in loss of any beneficial fishing impacts that could have occurred during O&M.

Offshore Activities and Facilities

Accidental releases and discharges: As discussed in the No Action Alternative (see Section 3.9.2.2), compliance with regulatory requirements would minimize releases of water quality contaminants and trash and debris. Additionally, training and awareness of EPMs proposed for waste management and reduction of marine debris would be required of Project personnel (see Table F-1 in Appendix F). Accidental spill or release of oils or other hazardous materials offshore would be managed through the OSRP. Therefore, during Project O&M, the impacts of accidental releases and discharges on target species catch in commercial and for-hire recreational fisheries are expected to be localized **negligible** adverse and short term or long term depending on the type and volume of material released. Details regarding potential water quality impacts to finfish and EFH are described in Section 3.13.

Anchoring: Potential impacts from anchoring vessels used during Project O&M would be the same as under the No Action Alternative (see Section 3.9.2.2) and are expected to be short term **negligible** to **minor** adverse. Details regarding potential navigation impacts to commercial and for-hire recreational fishing vessels are described in Section 3.16.

Climate change: As discussed in the No Action Alternative, impacts on commercial fisheries and for-hire recreational fishing in the GAA are expected to result from climate change trends. Risks to fisheries associated with these events include habitat and distribution shifts, disease incidence, and risk of invasive species. If the distribution of important fish stocks changes, it could affect where commercial and for-hire recreational fisheries are located. As under the No Action Alternative, impacts from climate change trends to commercial fisheries and for-hire recreational fishing during Project O&M are expected to be long term **minor** to **major** adverse for those fishing operations targeting species adversely affected by climate change trends and **minor** to **major** beneficial for those fishing operations targeting species beneficially affected by climate change trends.

As the Project becomes operational, the reduction in GHG emissions (or avoidance of increased GHG emissions from equivalent fossil fuel–powered energy production) would result in long-term beneficial impacts to fishing operations that target species adversely affected by climate change trends. However, given the global scale of GHG emissions, the benefits would be **negligible**. Section 3.4 describes the expected contribution of the Project to air emissions and climate change trends.

Light: Project O&M activities would have the same potential impact as Project construction but at a lower frequency over a longer period. Project EPMs include operational restrictions to limit light use to required periods and minimize artificial lighting effects on the environment (see Table F-1 in Appendix F). Project-related lighting impacts on target species catch in commercial and for-hire recreational fisheries are expected to be localized **negligible** to **minor** adverse and long term.

New cable emplacement/maintenance and EMF: Assuming two 42-mile-long export cables co-located within a single corridor and 155 miles of IACs (see Section 2.1.2), an estimated 239 miles of offshore export and IACs would be installed to support the maximum-case scenario under the Proposed Action. To the extent feasible, installation of the IAC, OSS-link cable, and RWEC would occur using equipment such as a mechanical cutter, mechanical plow, or jet plow. The feasibility of cable burial equipment would be determined based on an assessment of seafloor conditions and the cable burial risk assessment. In addition, to the extent feasible, the RWEC, IAC, and OSS-link cable would achieve a target burial depth of 4 to 6 feet (1.2 to 1.8 m) below the seafloor to reduce the occurrence of accidental snagging of fishing gear by burying all cables beneath the seafloor (see Table F-1 in Appendix F). Revolution Wind estimates that 19.5% of the route for each cable comprising the RWEC would require secondary cable protection for the following reasons: 1) because burial cannot occur, 2) because sufficient burial depth cannot be achieved due to seafloor conditions, or 3) to avoid risk of interaction with external hazards (VHB 2023). The impacts of this transmission cable infrastructure to commercial fisheries and for-hire recreational fishing through entanglement or gear loss/damage are discussed below under the presence of structures IPF.

As discussed in the No Action Alternative, fishermen have raised concerns regarding the behavioral impacts of EMF generated by submarine cables on target fish and invertebrates (BOEM 2018). The Project would employ HVAC transmission (VHB 2023), which generally produces lower intensity EMF than HVDC and may not be as detectable by electrosensitive fish and invertebrate species (see Sections 3.6 and 3.13). According to Revolution Wind, EMF levels, which are calculated using conservative assumptions likely to overestimate results, indicate that the magnetic field and induced electric field produced by the Project cables would be below the detection thresholds for magnetosensitive and electrosensitive marine organisms (VHB 2023). Consequently, EMF from Project cables are expected to have the same potential impact as the No Action Alternative; long-term **negligible** to **minor** adverse impacts on commercial and for-hire recreational fisheries.

Noise: As discussed in the No Action Alternative, Project construction activities that increase underwater noise could cause behavioral responses from some marine species or could result in reduced reproductive success for some species. In particular, operational noise could reduce the ability of hearing specialist species, like Atlantic cod, haddock (*Melanogrammus aeglefinus*), Atlantic pollock (*Pollachius virens*), and hake, to communicate effectively within a few hundred feet of each turbine. These impacts, in turn, could negatively impact catch levels in the fisheries targeting those species. Given the small area in which noise impacts would occur, Project-related O&M noise is expected to have a localized **minor** to **moderate** adverse impact on the catch of commercial fisheries and for-hire recreational fishing targeting these species.

Presence of structures: The presence of WTGs could result in de facto exclusion if fishing vessel operators are not—or perceive that they are not—able to safely navigate the area around WTGs. As described in Table F-1 in Appendix F, as part of the Project, Revolution Wind has committed to self-implement measures to facilitate safe navigation within the Lease Area. Revolution Wind is committed to an indicative layout scenario with WTGs sited in a grid with approximately 1.15 mile (1 nm) × 1.15 mile (1 nm) spacing that aligns with other proposed adjacent offshore wind energy projects in the RI/MA WEA. This layout has been confirmed through expert analysis to allow for safe navigation without the need for additional designated transit lanes. Each WTG would be marked and lit with both USCG navigation lighting and FAA aviation lighting. AISs would be installed at the RWF marking the corners of the wind farm to assist in safe navigation. In addition, Revolution Wind would create The Navigational Safety Fund, which would provide training and experiential learning opportunities to those navigating within the Lease Area off the coast of Rhode Island and Massachusetts. Fishermen eligible for the Direct Compensation Program and who do not already possess AIS transceivers and/or pulse compression radar systems may receive one-time grants for up to $10,000 in order to upgrade or purchase pulse compression radar or AIS. Commercial fishing vessels and inspected for-hire/party vessels would be eligible for $10,000 in upgrades, and uninspected for-hire vessels would be eligible for $5,000 in upgrades. Notwithstanding these measures, BOEM is cognizant that maneuverability within the Lease Area could vary depending on factors such as vessel size, fishing gear or method used, and/or environmental conditions.

The amount of commercial fishing revenue that would be annually exposed as a result of O&M activities in the Lease Area and along the RWEC would be the same as the amount exposed during construction. As described above, the largest impacts in terms of exposed revenue as a percentage of total revenue in the Mid-Atlantic and New England regions or as a percentage of total revenue in the RFA would be in the American Lobster, Atlantic Sea Scallop, and Mackerel/Squid/Butterfish FMP fisheries. The amount of commercial fishing revenue that would be exposed across all FMP and non-FMP fisheries is estimated to be $1.42 million. The annual exposed revenue represents 0.15% of the average annual revenue for all FMP and non-FMP fisheries in the Mid-Atlantic and New England regions, and 0.99% of the average annual revenue for all FMP and non-FMP fisheries in the RFA. Midwater trawl, all other, and pot gear would be the gear types most affected in terms of exposed revenue as a percentage of total revenue in the RFA. In terms of ports, the largest impacts in terms of exposed revenue as a percentage of total commercial fishing revenue in the RFA would be in the ports of Little Compton (7.4%) and Westport (5.7%).

As discussed above, revenue exposure estimates should not be interpreted as measures of actual economic impact. The actual economic impact to commercial fisheries during Project O&M would depend on many factors—foremost, the potential for continued fishing to occur in the Lease Area. It is also important to note that fishermen gain utility from being able to fish in locations that are known to them and are also fished by their peers; the presence of other boats in the area can contribute to the fishermen's sense of safety.

As described above, the amount of fishing activity that could be affected during Project O&M is a small fraction of the amount of fishing activity in the entire Mid-Atlantic and New England regions. However, a small number of fishing vessels historically derived a large percentage of their total fishing revenue from the area (see description of the Lease Area and RWEC in Section 3.9.1). For example, the vessel with the greatest dependence on the Lease Area derived 38% of its total revenue over the 2008–2021 period from the area. If these vessels choose to avoid the Lease Area during Project O&M and are unable to find suitable alternative fishing locations and continue to earn revenue, the adverse impacts would be long term **major** adverse. However, three-quarters of the vessels that fished in the Lease Area derived 0.88% or less of their total annual revenue from the area. Moreover, some fishing vessels that choose to avoid the Lease Area would likely be able to relocate to other fishing locations and continue to earn revenue. As a result, the adverse impacts of the presence of structures on most of the vessels are expected to be long term **negligible** to **moderate**.

In addition, as described in Table F-1 in Appendix F, Revolution Wind is committed to establishing a Direct Compensation Program for impacted fishermen. Revolution Wind would base the direct compensation program on findings from two separate CZMA consistency reviews conducted by the states of Rhode Island and Massachusetts and resulting mitigation agreements. The direct compensation programs, which are part of the mitigation agreements for the states of Rhode Island and Massachusetts, would address impacts to commercial fishing operations and for-hire recreational fishing operations. Understanding there may be impacts outside of Rhode Island and Massachusetts, Revolution Wind is committed to advancing and adhering to principles set forth by the nine-state initiative as well as ideals laid out in the BOEM guidance. In addition to the direct compensation programs created during the CZMA process, Revolution Wind would create or contribute to Coastal Community Funds in Rhode Island and Massachusetts. The contribution amounts would be determined during the CZMA process. The Coastal Community Funds would be grant-making entities, unrelated to Revolution Wind, and open to all fishing interests, including private recreational angling and onshore support businesses. Also described in Table F-1 in Appendix F is a fishing gear conflict prevention and claim procedure to be used when interactions between the fishing industries and Project activities or infrastructure cause undue interference with fishing gear. The use of this procedure for qualifying gear interactions that could occur during Project construction or O&M is considered part of the Proposed Action and would reduce any adverse impacts to commercial or for-hire recreational fishing operations due to fishing gear loss or damage.

Is estimated that during Project O&M, the revenue exposure for any given port would not exceed 8% of its total commercial fishing revenue from the Mid-Atlantic and New England regions or the RFA (see Table 3.9-27). Considering revenue risks across ports with the small number of vessels and fishing activity that would be affected during Project O&M, the impacts to other fishing industry sectors, including seafood processors and distributors and shoreside support services, would be long term **minor** to **moderate** adverse.

Transmission cable infrastructure could cause a potential safety hazard should gear snag or hook on secondary cable protection. Cables could become uncovered during extreme storm events or other natural occurrences. Transmission cable infrastructure, together with the scour protection around the monopile foundations, would result in permanent gear impacts if not removed at decommissioning. In addition, seafloor preparation prior to cable installation may relocate boulders and other obstructions that could cause gear damage or loss.

As discussed in the No Action Alternative, economic impacts to fishing operations associated with gear damage or loss include the costs of gear repair or replacement, together with the fishing revenue lost while gear is being repaired or replaced. Revolution Wind would implement a number of measures to reduce entanglement and damage or loss of fishing gear during Project operations. Revolution Wind would conduct bathymetry surveys of cable placements to confirm that cables remain buried and that rock placement and concrete mattresses remain secured and undamaged. Surveys would be performed 1 year after commissioning, 2 to 3 years after commissioning, and 5 to 8 years after commissioning. Survey frequency thereafter would depend on the findings of the initial surveys (i.e., site seafloor dynamics and soil conditions). A survey could also be conducted after a major storm event (VHB 2023). Decommissioning would involve removing all components in the RWF to a depth of 15 feet (4.6 m) below the mudline (VHB 2023). In addition, as described above, presents a fishing gear conflict prevention and claim procedure that would reduce any adverse impacts to commercial or for-hire recreational fishing operations due to fishing gear damage or loss. As a result of these measures, the impact of buried submarine cables to commercial fisheries and for-hire recreational fishing through entanglement or gear loss/damage is expected to be long term **negligible** to **minor** adverse where cable burial can occur and long term **moderate** adverse where cable burial cannot occur.

The presence of the WTG and OSS foundations and associated scour protection would convert existing sand or sand with mobile gravel habitat to hard bottom, which in turn would reduce the habitat for target species that prefer soft-bottom habitat (e.g., squid, summer flounder, and surfclam) and increase the habitat for target species that prefer hard-bottom habitat (e.g., lobster, striped bass, black sea bass, and cod) (see Sections 3.6 and 3.13). However, given the small footprint of the Lease Area and RWEC, any localized adverse impacts to target species populations from habitat alteration would have a **negligible** to

moderate effect on the catch of for-hire recreational and commercial fisheries depending on the species targeted. As discussed in the No Action Alternative, where WTG and OSS foundations and associated scour protection produce an artificial reef effect and attract finfish and invertebrates, the aggregation of species could increase the catch rates of some target species. With respect to the Project, it is expected that the reef effect of the WTG foundations would have long-term **negligible** to **minor** beneficial impacts to for-hire recreational fishing, depending on the extent to which the foundations attract targeted species. Additionally, the presence of food or shelter associated with the structures could alter the migratory behaviors of some species. In particular, the potential for disruption of inshore to offshore migratory patterns of important species such as lobster and black sea bass has been identified as a topic of concern (see Sections 3.6 and 3.13). Overall, localized adverse or beneficial impacts to target species populations from habitat alteration would have a long-term **negligible** to **moderate** effect on the target species catch of for-hire recreational and commercial fisheries.

As discussed in the No Action Alternative, the offshore structures associated with offshore wind energy development could also affect commercial fisheries and for-hire recreational fishing by preventing or hampering NMFS's ongoing scientific surveys on which fishery management measures are based. Additional information on impacts to NMFS's scientific research and protected species surveys is provided in Section 3.17.

Vessel traffic: In comparison to the construction phase, Project O&M would require a more limited number of vessels, and most of the vessels would be smaller in size (VHB 2023). Although the total number of vessel transits would increase during O&M relative to construction, O&M vessel traffic would not have the same influx of vessels during a compressed time period as expected during construction. As a result, the increased vessel transits during O&M are not expected to result in a significant increase in the overall traffic volume or patterns (VHB 2023) (see Section 3.16).

During Project O&M, some commercial fishermen could avoid the Lease Area if large numbers of recreational fishermen are drawn to the area by the prospect of higher catches due to the artificial reef effect. Overall, the adverse effects of Project O&M to commercial fisheries and for-hire recreational fishing are expected to be long term **minor** to **moderate**.

Onshore Activities and Facilities

Port utilization: During Project O&M, port facilities would be required for vessels used for routine maintenance of offshore Project components. These vessels would require berthing and would add traffic to port facilities. The additional vessel volume in ports could cause reduced access to high-demand port services (e.g., fueling and provisioning) by existing port users, including commercial fishing vessels and for-hire recreational fishing vessels. However, in comparison to the construction phase, Project O&M would require a more limited number of vessels (VHB 2023) (see Section 3.16). Given the low level of Project-related vessel traffic during O&M, the normal or routine functions of commercial and for-hire recreational fishing vessels within ports are not expected to be disrupted. Therefore, the adverse impacts on the accessibility of port facilities by commercial fishing vessels and for-hire recreational fishing vessels would be long term **minor**.

3.9.2.3.3 Cumulative Impacts

Offshore Activities and Facilities

Accidental releases and discharges: As discussed in the No Action Alternative (see Section 3.9.2.2), ongoing and future activities that reduce water quality could in turn decrease target species catch rates over the short term or long term depending on the type and volume of material released.

Compliance with regulatory requirements would effectively minimize releases of water quality contaminants and trash or debris. For this reason, the impacts of accidental releases and discharges of the Proposed Action on the target species catch of commercial and for-hire recreational fisheries would be undetectable. The impacts of the Proposed Action when combined with the impacts of present and other reasonably foreseeable activities are expected to be localized **negligible** to **minor** adverse and short term to long term.

Anchoring: Impacts from anchoring due to present and future military, survey, commercial, and recreational activities, including the Proposed Action, could pose a navigational hazard to commercial and for-hire recreational fishing vessels in the GAA. All impacts would be localized (within a few hundred yards of anchored vessel) and temporary (hours to days). The anchoring impacts of the Proposed Action on commercial and for-hire recreational fisheries would be the same as the No Action Alternative (see Section 3.9.2.2) and undetectable. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be short term **negligible** to **moderate** adverse.

Climate change: The types of impacts from global climate change trends to commercial fisheries and for-hire recreational fishing described for the No Action Alternative would occur under the Proposed Action (see Table E2-12 in Appendix E1). These impacts are expected to be long term **minor** to **major** adverse for those fishing operations targeting species adversely affected by climate change trends and **minor** to **major** beneficial for those fishing operations targeting species beneficially affected by climate change trends.

As they become operational, future offshore wind facilities, including the Proposed Action, would produce fewer GHG emissions than fossil fuel–powered generating facilities with similar capacities. This reduction in GHG emissions (or avoidance of increased GHG emissions from equivalent fossil fuel–powered energy production) would result in long-term benefits to fishing operations that target species adversely affected by climate change trends. However, given the global scale of GHG emissions, the benefits would be **negligible**.

Light: Ongoing and future offshore activities, including the Proposed Action, that introduce artificial lighting could result in behavioral responses from some target species. In turn, these responses could decrease target species catch rates, thereby reducing revenue for commercial fishing and for-hire recreational fishing businesses. The light impacts of the Proposed Action on commercial and for-hire recreational fisheries would be undetectable. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be long term **minor** to **moderate** adverse.

New cable emplacement/maintenance and EMF: As indicated in the discussed under the cumulative impacts discussion for the No Action Alternative, offshore wind energy development could result in the emplacement of up to 13,469 miles of offshore export and IACs. The Project would add an additional 239 miles of cable to this total, which is a 2% increase. To the fullest extent possible, future offshore wind energy projects would reduce the occurrence of accidental snagging of fishing gear by burying all cables beneath the seafloor. Therefore, the impact of buried submarine cables to commercial fisheries and for-hire recreational fishing from the Proposed Action would be the same as the impacts from the No Action Alternative: long term **moderate** adverse. In areas where cable burial cannot occur, other methods of cable protection would be employed, such as articulated concrete mattresses or rock placement. Impacts of this transmission cable infrastructure to commercial fisheries and for-hire recreational fishing through entanglement or gear loss/damage and navigation hazards are discussed below under the presence of structures IPF.

Although fishermen have raised concerns regarding the suspected behavioral impacts of EMF generated by submarine cables on target fish and invertebrates, 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). Therefore, the impacts of EMF on commercial fisheries and for-hire recreational fishing are expected to be long term **negligible** to **minor** adverse.

Noise: Ongoing and future offshore activities, including the Proposed Action, that increase underwater noise could decrease the catch rates for some target species, thereby reducing the revenue for commercial fishing and for-hire recreational fishing businesses. These noise impacts are expected to be long term **moderate** adverse.

Presence of structures: Most offshore structures in the GAA would be attributable to the offshore wind industry. As provided in Table E3-1 in Appendix E3 and discussed under the No Action Alternative, offshore wind energy development could result in the installation of 3,088 WTG and OSS foundations through 2030. The impact of the Project would be noticeable because it would add as many as 102 foundations, which is a 3% increase.

The addition of these new structures and cables in the GAA could adversely impact commercial fisheries and for-hire recreational fishing due to potential increased space-use conflicts that may result in navigational hazards, allisions, and gear loss/damage. Vessels would have an increasingly difficult time finding new places to fish if displaced by other regional offshore wind energy projects. Therefore, cumulative impacts on fishing operations would increase as more of these projects are developed. Fishing revenue would be foregone if these impacts cause fishing vessel operators to no longer fish in affected areas, and they cannot capture that revenue in different locations. If the Project is not included, the annual commercial fishing revenue exposed at the end of the project development timeline for all planned offshore wind energy lease areas in the Mid-Atlantic and New England regions is estimated to be approximately $34.0 million (see Table 3.9-24). Based on the data in Table 3.9-25, the Proposed Action would increase the commercial fishing revenue at risk by $1.42 million, which is an increase of approximately 4.2%.

With respect to impacts to individual fishing operations, some of the small number of fishing operations that derive a large percentage of their total revenue from areas where offshore wind energy facilities would be located could choose to avoid these areas once the facilities become operational. In the event that these fishing operations are unable to find suitable alternative fishing locations, they could experience long-term **major** adverse impacts. However, most fishing vessels would only have to adjust somewhat to account for disruptions due to the presence of structures. A majority derive a small percentage of their total revenue from any one lease area or would be able to relocate to other fishing locations. In addition, the impacts of offshore wind energy facilities could include long-term **minor** beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect, which would increase the catch rates for some target species.

Overall, BOEM expects that the cumulative adverse impacts of the presence of structures resulting from the Project and other past, present, and reasonably foreseeable activities would be long term and **moderate** to **major,** depending on the fishery and fishing operation. If BOEM's recommendations related to project siting, design, navigation, access, safety measures, and financial compensation are implemented across all offshore wind energy projects (see BOEM 2022), adverse impacts on commercial fisheries due to the presence of structures could be reduced.

Vessel traffic: The GAA is expected to continue to have extensive marine traffic related to shipping, fishing, and other activities, and the risk for vessel collisions would be ongoing but infrequent due to the implementation of the *Fisheries Communication and Outreach Plan* prepared by Orsted U.S. Offshore Wind (2020). The vessel traffic impacts of the Proposed Action on commercial and for-hire recreational fisheries would be noticeable, but the risk of vessel collisions is expected to remain low. When combined with the impacts of present and other reasonably foreseeable activities, the impacts are expected to be long term **minor** to **moderate** adverse.

Onshore Activities and Facilities

Port utilization: The major ports in the GAA are anticipated to continue to have increasing vessel visits, and vessel size is also expected to increase. The increased vessel traffic in ports could result in delays or restrictions in access to ports and increased competition for dockside services. Future offshore wind energy projects, including the Project, would contribute to the increase in vessel traffic. This additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to, and higher costs for, high-demand port services (e.g., fueling and provisioning) by existing port users, including commercial fishing vessels and for-hire recreational fishing vessels. These potential adverse impacts could cause some fishing vessel operators to use an alternative port (see Sections 3.16 and 3.11). As fishing vessels shift the location of their landings and shoreside service activities, the result could be economic losses and a decline in fisheries-related onshore infrastructure in some ports but could be economic gains and enhanced infrastructure in others.

However, regardless of whether or not offshore wind energy development, including the Project, occurs, most ports are going through continual upgrades and maintenance to ensure that they can receive projected future volumes of vessels. State and local agencies would be responsible for minimizing the potential adverse impacts of additional port utilization by managing traffic to ensure continued access to port facilities (see Section 3.16). In addition, the use of multiple ports to support offshore wind energy project development would reduce the related congestion impacts in any one port. Therefore, the port utilization impacts of present and other reasonably foreseeable activities to commercial fisheries and for-hire recreational fishing are expected to be localized and long term **minor** to **moderate** adverse.

Conclusions

Construction and installation, O&M, and decommissioning of the Proposed Action could impact commercial fisheries and for-hire recreational through restricted port access, increased space-use conflicts, and reduced catch levels of target species. The impacts under the Proposed Action resulting from individual IPFs would range from short term to long term and **negligible** to **major** adverse, with the duration and intensity of impacts varying by Project phase and by fishery and fishing operation due to differences in target species, gear type, and predominant location of fishing activity. With EPMs, it is estimated that the majority of vessels would only have to adjust somewhat to account for disruptions due to impacts. In addition, the impacts of the Proposed Action could include long-term **minor** beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect.

Considering all the IPFs together, BOEM anticipates that the overall impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in an overall long-term **major** adverse impact because some commercial and for-hire recreational fisheries and fishing operations would experience substantial disruptions indefinitely even if remedial action is taken. This impact level is primarily driven by climate change trends, fisheries management activities, and the presence of offshore structures. The majority of offshore structures in the GAA would be attributable to the offshore wind industry.

3.9.2.4 Alternatives C, D, E, and F

3.9.2.4.1 Construction and Installation

Offshore Activities and Facilities

<u>Presence of structures</u>: In general, impacts on commercial fisheries from the presence of structures would be the same or similar to the Proposed Action. However, by omitting certain WTG positions, Alternatives C through F would reduce the adverse impact of the presence of structures on commercial fisheries and for-hire recreational fishing during Project construction. In comparison to the Proposed Action, fishing access would be improved and the risk of fishing gear loss/damage would be reduced.

Based on NMFS 2008–2019 data, Tables G-CF10 through G-CF21 in Appendix G show the estimated number of vessels and vessel trips that would be affected as a result of construction activities in the Lease Area and along the RWEC under Alternatives C1, C2, and E2 (NMFS 2021a, 2022b). Under all these alternatives, the impacts in terms of the number of vessels active in the Lease Area and along the RWEC as a percentage of total fishing effort in the RFA across FMP fisheries, species, gear types, and ports would be the same or similar to the Proposed Action. Vessel and trip data for all design configurations of Alternative D and for Alternate E1 could not be provided because the data were provided separately for the Lease Area and RWEC. Combining the data for the two areas could result in double counting. Vessel and trip data for Alternative F could not be provided because it is uncertain what WTG positions would be omitted under this alternative.

Based on NMFS 2008–2019 data, Tables G-CF26 through G-CF58 in Appendix G show the estimated amount of commercial fishing revenue that would be exposed as a result of construction activities in the Lease Area and along the RWEC under each configuration for Alternatives C through E (NMFS 2021a, 2022b). The estimates are shown by FMP fishery, gear type, and port.

As under the Proposed Action, under all the design configurations of Alternatives C, D, and E, the largest impacts in terms of exposed revenue as a percentage of total revenue in the RFA would be in the Spiny Dogfish, American Lobster, Atlantic Herring, and Northeast Skate Complex FMP fisheries. Table 3.9-28 summarizes the estimated amount of commercial fishing revenue that would be exposed across all FMP and non-FMP fisheries under the design configurations of Alternatives C, D, and E.

Table 3.9-28. Estimated Annual Commercial Fishing Revenue Exposed in the Lease Area and along the Revolution Wind Export Cable Across all FMP and Non-FMP fisheries under Alternatives C, D, and E

Alternative	Annual Revenue at Risk (millions)	Average Annual Revenue at Risk as a Percentage of Total Revenue in the RFA
C1	$1.33	0.92
C2	$1.27	0.88
D1	$1.34	0.93
D2	$1.37	0.95
D3	$1.35	0.94
D1+D2	$1.30	0.90
D1+D3	$1.27	0.88
D2+D3	$1.30	0.90
D1+D2+D3	$1.23	0.85
E1	$1.06	0.74
E2	$1.17	0.81

Source: Developed using 2008-2019 data from NMFS (2021a, 2022b).

The amount of commercial fishing revenue that would be exposed across all FMP and non-FMP fisheries is estimated to be $1.33 million under Alternative C1 and $1.27 million under Alternative C2. The annual exposed revenue as a percentage of average annual revenue for all FMP and non-FMP fisheries in the RFA would be 0.92% under Alternative C1 and 0.88% under Alternative C2. Midwater trawl, all other, and pot gear would be the gear types most affected in terms of exposed revenue as a percentage of total revenue in the RFA. In terms of ports, the largest impacts in terms of exposed revenue as a percentage of total commercial fishing revenue in the RFA would be in Little Compton (6.8%), Westport (5.0%), and Newport (3.6%) under Alternative C1 and Little Compton (6.5%), Westport (4.2%), and Newport (3.5%) under Alternative C2.

The amount of commercial fishing revenue that would be exposed across all FMP and non-FMP fisheries is estimated to be $1.34 million under Alternative D1, $1.37 million under Alternative D2, $1.35 million under Alternative D3, $1.30 million under D1+D2, $1.27 million under D1+D3, $1.30 million under D2+D3, and $1.23 million under D1+D2+D3. The annual exposed revenue as a percentage of average annual revenue for all FMP and non-FMP fisheries in the RFA would be 0.93% under Alternative D1, 0.95% under Alternative D2, 0.94% under Alternative D3, 0.90% under D1+D2, 0.88% under D1+D3, 0.90% under D2+D3, and 0.85% under D1+D2+D3. Midwater trawl, all other, and pot gear would be the gear types most affected in terms of exposed revenue as a percentage of total revenue in the RFA. In terms of ports, the largest impacts in terms of exposed revenue as a percentage of total commercial fishing revenue in the RFA would be in Little Compton (7.0%), Westport (5.3%), and Chilmark/Menemsha (3.8%) under Alternative D1; Little Compton (7.3%), Westport (5.6%), and Newport (3.7%) under

Alternative D2; Little Compton (12.5%), Westport (10.5%), and Chilmark/Menemsha (7.9%) under Alternative D3; Little Compton (6.9%), Westport (5.2%), and Newport (3.6%) under Alternative D1+D2; Little Compton (6.6%), Westport (5.2%), and Chilmark/Menemsha (3.7%) under Alternative D1+D3; Little Compton (7.0%), Westport (5.5%), and Newport (3.6%) under Alternative D2+D3; and Little Compton (6.5%), Westport (5.1%), and Newport (3.5%) under Alternative D1+D2+D3.

The amount of commercial fishing revenue that would be exposed across all FMP and non-FMP fisheries is estimated to be $1.06 million under Alternative E1 and $1.17 million under Alternative E2. The annual exposed revenue as a percentage of average annual revenue for all FMP and non-FMP fisheries in the RFA would be 0.74% under Alternative E1 and 0.81% under Alternative E2. Midwater trawl, all other, and sink gillnet gear would be the gear types most affected in terms of exposed revenue as a percentage of total revenue in the RFA. In terms of ports, the largest impacts in terms of exposed revenue as a percentage of total commercial fishing revenue in the RFA would as follows: Little Compton (5.5%), Westport (3.6%), and Newport (3.1%) under Alternative E1 and Little Compton (6.2%), Westport (5.0%), and Chilmark/Menemsha (3.7%) under Alternative E2.

The estimated amount of commercial fishing revenue that would be exposed as a result of construction activities in the Lease Area and along the RWEC would be lower for all design configurations under Alternatives C through E than under the Proposed Action ($1.42 million). However, the amount of exposed revenue as a percentage of average annual revenue for all FMP and non-FMP fisheries in the RFA under all design configurations would be similar to that for the Proposed Action (0.99%). Therefore, the impact level from the presence of structures for all design configurations would be similar to that for the Proposed Action: short term **negligible** to **moderate** adverse for the majority of commercial fishing vessels but short term **major** adverse for a small number of vessels.

It is uncertain what WTG positions would be omitted under Alternative F. Consequently, it is not possible to estimate the amount of commercial fishing revenue that would be exposed as a result of construction activities in the Lease Area and along the RWEC under this alternative. However, the impact level from the presence of structures for Alternative F is expected to be similar to that for the Proposed Action: short term **minor** to **moderate** adverse.

3.9.2.4.2 Operations and Maintenance and Conceptual Decommissioning

Offshore Activities and Facilities

<u>Presence of structures</u>: In general, impacts on commercial fisheries from the presence of structures would be the same or similar to the Proposed Action. However, by omitting certain WTG positions, Alternatives C through F would reduce the adverse impact of the presence of structures on commercial fisheries and for-hire recreational fishing during Project O&M. In comparison to the Proposed Action, fishing access would be improved, and the risk of fishing gear loss/damage would be reduced.

The amount of commercial fishing revenue that would be exposed as a result of O&M activities in the Lease Area and along the RWEC would be the same as the amount exposed during construction. As described above, under all design configurations, the largest impacts in terms of exposed revenue as a percentage of total revenue in the Mid-Atlantic and New England regions or as a percentage of total revenue in the RFA would be in the Spiny Dogfish, Atlantic Herring, and American Lobster FMP fisheries.

3.9.2.4.3 Cumulative Impacts

Offshore Activities and Facilities

Presence of structures: The addition of both new structures and new cables in the GAA could adversely impact commercial fisheries and for-hire recreational fishing due to potential increased space-use conflicts that may result in navigational hazards, allisions, and gear loss/damage. Fishing revenue would be foregone if these impacts cause fishing vessel operators to no longer fish in affected areas, and they cannot capture that revenue in different locations. If the Project is not included, the amount of commercial fishing revenue exposed by planned offshore wind energy development in the Mid-Atlantic and New England regions is estimated to be approximately $34.0 million per year by 2029 (see Table 3.9-24). As described in Section 3.9.2.2.3, the Proposed Action would increase the commercial fishing revenue at risk by $1.42 million, which is an increase of approximately 4.2%.

Alternative C would increase the commercial fishing revenue at risk by $1.33 million under Alternative C1 and $1.27 million under Alternative C2. These impacts add 3.9% and 3.7%, respectively, to the revenue exposed by planned offshore wind energy development in the Mid-Atlantic and New England regions.

Alternative D would increase the commercial fishing revenue at risk by $1.34 million under Alternative D1, $1.37 million under Alternative D2, $1.35 million under Alternative D3, $1.30 million under D1+D2, $1.27 million under D1+D3, $1.30 million under D2+D3, and $1.23 million under D1+D2+D3. These impacts add from 3.6% (under D1+D2+D3) to 4.0% (under D2) to the revenue exposed by planned offshore wind energy development in the Mid-Atlantic and New England regions.

Alternative E would increase the commercial fishing revenue at risk by $1.06 million under Alternative E1 and $1.17 million under Alternative E2. These impacts add 3.1% and 3.4%, respectively, to the revenue exposed by planned offshore wind energy development in the Mid-Atlantic and New England regions.

As described above, for Alternative F, it is not possible to estimate the amount of commercial fishing revenue that would be exposed as a result of Project activities in the Lease Area and along the RWEC because it is uncertain what WTG positions would be omitted under this alternative.

Overall, BOEM expects that the cumulative impacts of the presence of structures resulting from all design configurations under Alternatives C through F and other past, present, and reasonably foreseeable activities would be similar to the cumulative impacts under the Proposed Action: long term **moderate** to **major** adverse depending on the fishery and fishing operation. If BOEM's recommendations related to project siting, design, navigation, access, safety measures, and financial compensation are implemented across all offshore wind energy projects, adverse impacts on commercial fisheries due to the presence of structures could be reduced.

3.9.2.4.4 Conclusions

Alternatives C through F under all layout options could result in fewer WTGs compared to the maximum scenarios under the Proposed Action, which would decrease the potential for space-use conflicts that may result in navigational hazards, allisions, and fishing gear loss/damage in commercial and for-hire recreational fisheries. However, BOEM expects that for all design configurations analyzed, the impacts resulting from individual IPFs would be similar to the Proposed Action: short term to long term and **negligible** to **major** adverse, with the duration and intensity of impacts varying by Project phase and fishery and fishing operations due to differences in target species, gear type, and predominant location of fishing activity. With EPMs, it is estimated that the majority of vessels would only have to adjust somewhat to account for disruptions due to impacts. In addition, the impacts of Alternatives C through F could include long-term **minor** beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect.

The overall impacts of Alternatives C through F when combined with past, present, and reasonably foreseeable activities would be the same as under the Proposed Action: long term **major** adverse, primarily as a result of climate change trends, fisheries management activities, and the presence of offshore structures. The majority of offshore structures in the GAA would be attributable to the offshore wind industry.

3.9.2.5 Alternative G: Impacts of the Preferred Alternative on Commercial Fisheries and For-Hire Recreational Fishing

3.9.2.5.1 Construction and Installation

Offshore Activities and Facilities

Presence of structures: By omitting certain WTG positions, Alternative G would reduce the adverse impact of the presence of structures on commercial fisheries and for-hire recreational fishing during Project construction. In comparison to the Proposed Action, fishing access would be improved, and the risk of fishing gear loss/damage would be reduced.

Tables G-CF22 through G-CF25 in Appendix G show the estimated number of vessels and vessel trips anticipated to be affected as a result of construction activities in the Lease Area and along the RWEC under Alternative G based on NMFS 2008–2019 data NMFS (2021a, 2023a). The impacts in terms of the number of vessels active in the Lease Area and along the RWEC as a percentage of total fishing effort in the RFA across FMP fisheries, species, gear types, and ports would be the same or similar to the Proposed Action.

Tables G-CF59 through G-CF61 in Appendix G show the estimated amount of commercial fishing revenue that would be exposed as a result of construction activities in the Lease Area and along the RWEC under Alternative G. The estimates are shown by FMP fishery, gear type, and port. As under the Proposed Action, the largest impacts under Alternative G in terms of exposed revenue as a percentage of total revenue in the RFA would be in the Spiny Dogfish, American Lobster, Atlantic Herring, and Northeast Skate Complex FMP fisheries. The amount of commercial fishing revenue that would be exposed across all FMP and non-FMP fisheries is estimated to be $1.14 million under Alternative G. The annual exposed revenue as a percentage of average annual revenue for all FMP and non-FMP fisheries in the RFA would be 0.79%. Midwater trawl, all other, and sink gillnet gear would be the gear types most affected in terms of exposed revenue as a percentage of total revenue in the RFA. In terms of ports, the largest impacts in terms of exposed revenue as a percentage of total commercial fishing revenue in the RFA would be in Little Compton (6.4%), Westport (5.1%), and Chilmark/Menemsha (3.6%).

More information on the annual commercial fishing revenue at risk under Alternative G is provided in Appendix G. Appendix G Table G-CF66 shows the commercial fishing revenue in the entire Lease Area

(Figure 1.1-2) and the Lease Area under Alternative G (Figure 2.1-22) by state of landing for each year from 2008 to 2021. Table G-CF67 compares the average annual commercial fishing revenue in the entire Lease Area and the Lease Area under Alternative G by state of landing based on the data for two different time periods: 2008–2019 and 2008–2021.

The estimated amount of commercial fishing revenue that would be exposed as a result of construction activities in the Lease Area and along the RWEC would be lower under Alternative G than under the Proposed Action ($1.42 million). However, the amount of exposed revenue as a percentage of average annual revenue for all FMP and non-FMP fisheries in the RFA would be similar to that for the Proposed Action (0.99%). Therefore, the impact level from the presence of structures would be similar to that for the Proposed Action: short term **negligible** to **moderate** adverse for the majority of commercial fishing vessels but short term **major** adverse for a small number of vessels.

3.9.2.5.2 Operations and Maintenance and Conceptual Decommissioning

Offshore Activities and Facilities

Presence of structures: By omitting certain WTG positions, Alternative G would reduce the adverse impact of the presence of structures on commercial fisheries and for-hire recreational fishing during Project O&M. In comparison to the Proposed Action, fishing access would be improved, and the risk of fishing gear loss/damage would be reduced.

The amount of commercial fishing revenue that would be exposed as a result of O&M activities in the Lease Area and along the RWEC would be the same as the amount exposed during construction. As described above, under all design configurations, the largest impacts in terms of exposed revenue as a percentage of total revenue in the Mid-Atlantic and New England regions or as a percentage of total revenue in the RFA would be in the Spiny Dogfish, Atlantic Herring, and American Lobster FMP fisheries.

3.9.2.5.3 Cumulative Impacts

Offshore Activities and Facilities

Presence of structures: The addition of both new structures and new cables in the GAA could adversely impact commercial fisheries and for-hire recreational fishing due to potential increased space-use conflicts that may result in navigational hazards, allisions, and gear loss/damage. Fishing revenue would be foregone if these impacts cause fishing vessel operators to no longer fish in affected areas, and they cannot capture that revenue in different locations. If the Project is not implemented, the amount of commercial fishing revenue exposed by planned offshore wind energy development in the Mid-Atlantic and New England regions is estimated to be approximately $34.0 million per year by 2029 (see Table 3.9-24). As described in Section 3.9.2.2.3, the Proposed Action would increase the commercial fishing revenue at risk by $1.42 million, which is an increase of approximately 4.2%.

Alternative G would increase the commercial fishing revenue at risk by $1.14 million. This impact adds 3.3% to the revenue exposed by planned offshore wind energy development in the Mid-Atlantic and New England regions.

Overall, BOEM anticipates that the cumulative impacts of the presence of structures resulting from Alternative G and other past, present, and reasonably foreseeable activities would be similar to the cumulative impacts under the Proposed Action: long term **moderate** to **major** adverse depending on the fishery and fishing operation. If BOEM's recommendations related to project siting, design, navigation, access, safety measures, and financial compensation are implemented across all offshore wind energy projects, adverse impacts on commercial fisheries due to the presence of structures could be reduced.

Conclusions

Alternative G would result in fewer WTGs installed compared to the maximum scenario under the Proposed Action, which would decrease the potential for space-use conflicts that may result in navigational hazards, allisions, and fishing gear loss/damage in commercial and for-hire recreational fisheries. However, BOEM expects the impacts resulting from individual IPFs would be similar to the Proposed Action: short term to long term and **negligible** to **major** adverse, with the duration and intensity of impacts varying by Project phase and fishery and fishing operations due to differences in target species, gear type, and predominant location of fishing activity. With EPMs, it is estimated that most vessels would only have to adjust somewhat to account for disruptions due to impacts. In addition, the impacts of Alternative G could include long-term **minor** beneficial impacts for some for-hire recreational fishing operations due to the artificial reef effect.

The overall impacts of Alternative G when combined with past, present, and reasonably foreseeable activities would be the same as the Proposed Action: long term **major** adverse, primarily as a result of climate change trends, fisheries management activities, and the presence of offshore structures. Most of the offshore structures in the GAA would be attributable to the offshore wind industry.

3.9.2.6 Mitigation

Mitigation measures resulting from agency consultations for benthic habitat and invertebrates are identified in Appendix F, Table F-2, and addressed in Table 3.9-29. Additional mitigation and monitoring measures identified by BOEM are provided in Table F-3 in Appendix F and addressed in Table 3.9-30.

Table 3.9-29. Mitigation and Monitoring Measures Resulting from Consultations for Commercial Fisheries and For-Hire Recreational Fishing (Appendix F, Table F-2)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Locations of boulders, berms, and protection measures	Locations of relocated boulders, created berms, and scour protection, including cable protection measures (i.e., concrete mattresses) should be provided to NMFS and the public as soon as possible to help inform marine users, including the fishing industry and entities conducting scientific surveys of potential gear obstructions.	This measure, if adopted, would assist agency, public, and industry to avoid potential seafloor obstructions.

Table 3.9-30. Additional Mitigation and Monitoring Measures for Commercial Fisheries and For-Hire Recreational Fishing (Appendix F, Table F-3)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Boulder relocation plan	Revolution Wind must submit to BOEM a boulder relocation plan that will include the following: 1) Identification of areas of active (within last 5 years) bottom trawl fishing, areas where boulders greater than 2 m in diameter are anticipated to occur, and areas where boulders are expected to be relocated for Project purposes. 2) Methods to minimize the quantity of seafloor obstructions from relocated boulders in areas of active bottom trawl fishing, as identified in #1. The plan must be submitted to BOEM at least 90 days prior to IAC corridor preparation and cable installation (e.g., boulder relocation, pre-cut trenching, cable crossing installation, cable lay and burial) and foundation site preparation (e.g., scour protection installation).	This measure, if adopted, would minimize the number of potential seafloor obstructions that may interact with bottom trawl fisheries.
Mobile gear–friendly cable	Cable protection measures should reflect the preexisting conditions at the site. This mitigation measure chiefly ensures that seafloor cable protection does not introduce new hangs for	This measure, if adopted, would ensure that seafloor cable protection does not introduce new hangs for mobile fishing gear (reducing impacts from the Presence of Structures IPF).

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
protection measures	mobile fishing gear. Thus, the cable protection measures should be trawl-friendly with tapered/sloped edges. If cable protection is necessary in "non-trawlable" habitat, such as rocky habitat, then the lessee should consider using materials that mirror the benthic environment.	
Post-installation cable monitoring	Revolution Wind must provide BOEM with a cable monitoring report within 45 calendar days following each IAC and export cable inspection to determine cable location, burial depths, state of the cable, and site conditions. An inspection of the inter-array cable and export cable is expected to include high-resolution geophysical (HRG) methods, such as a multi-beam bathymetric survey equipment, and is expected to identify seabed features, natural and human-made hazards, and site conditions along federal sections of the cable routing. In federal waters, the initial IAC and export cable inspection would be carried out within 6 months of commissioning, and subsequent inspections would be carried out at years 1 and 2, then every 3 years thereafter, and after a major storm event. Major storm events are defined as when metocean conditions at the facility meet or exceed the 1 in 50-year return period calculated in the metocean design basis, to be submitted to BOEM with the facility design report (FDR). If conditions warrant adjustment to the frequency of inspections following the Year 2 survey, a revised monitoring plan may be provided to BOEM for review. In addition to inspection, the export cable would be monitored continuously with the as-built distributed temperature sensing system. If distributed temperature sensing data indicate that burial conditions have deteriorated or changed significantly and remedial actions are warranted, the distributed temperature sensing data, a seabed stability analysis, and report of remedial actions taken or scheduled must be provided to BOEM within 45 calendar days of the observations.	This measure, if adopted, would ensure that seafloor cables remain buried, reducing impacts from potential gear entanglement and damage.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	The Distributed Temperature Sensing data, cable monitoring survey data, and cable conditions analysis for each year must be provided to BOEM as part of the annual compliance reports, required by 30 CFR 285.633(b).	
Federal survey mitigation guidance	There are 14 NMFS scientific surveys that overlap wind energy development in the northeast region, and nine of these surveys overlap the Project. Per NMFS and BOEM survey mitigation strategy actions 1.3.1, 1.3.2, 2.1.1, and 2.1.2 (Hare et al. 2022), within 120 calendar days of COP approval, Revolution Wind must submit to BOEM a draft survey mitigation agreement between NMFS and Revolution Wind. The survey mitigation agreement will describe how Revolution Wind will mitigate the Project impacts on the nine NMFS surveys. If after consultation with NMFS NEFSC, BOEM deems the survey mitigation agreement acceptable, the mitigation will be considered required as a term and condition of the Project's COP approval. As soon as reasonably practicable, but no later than 30 days after the issuance of the Project's COP approval, Revolution Wind will initiate coordination with NMFS NEFSC to develop the survey mitigation agreement described above. Mitigation activities specified under the agreement will be designed to mitigate the Project impacts on the following NMFS NEFSC surveys: a) spring bottom trawl survey, b) autumn multi-species bottom trawl survey, c) ecosystem monitoring survey, d) NARW aerial survey, e) aerial marine mammal and sea turtle survey, f) shipboard marine mammal and sea turtle survey, g) Atlantic surfclam and ocean quahog survey, h) Atlantic sea scallop survey; and (i) seal survey. At a minimum, the survey mitigation agreement will describe actions needed and the means to address impacts on the affected surveys due to the preclusion of sampling platforms and impacts on statistical designs. In terms of statistical design, the Project will be viewed as a discrete stratum in surveys that use a random stratified design. Other anticipated Project impacts on NMFS surveys such as changes in habitat and increased operational costs	This measure, if adopted, would reduce uncertainty in scientific survey results, which would reduce uncertainty in stock assessments and quota setting processes. This reduced uncertainty, in turn, would help avoid more conservative catch quotas and/or more restrictive effort management measures for commercial and recreational fisheries.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	due to loss of sampling efficiencies may also be addressed in the agreement. The survey mitigation agreement will identify activities that will result in the generation of data equivalent to data generated by NMFS's affected surveys for the duration of the Project. The survey mitigation agreement will describe the implementation procedures by which Revolution Wind will work with NEFSC to generate, share, and manage the data required by NEFSC for each of the surveys impacted by the Project, as mutually agreed upon between Revolution Wind and NMFS/NEFSC. The survey mitigation agreement must also describe Revolution Wind's participation in the NMFS NEFSC Northeast Survey Mitigation Program to support activities that address regional-level impacts for the surveys listed above.	
Shoreside seafood business analysis	In addition to the Direct Compensation Fund proposed by Revolution Wind, BOEM would require Revolution Wind to ensure that the Direct Compensation Fund includes losses to shoreside seafood support services. Revolution Wind shall analyze the impacts to shoreside seafood support services within the communities nearby ports listed in Table 3.9-12. The shoreside seafood business analysis would be used to further supplement funds available for settling claims of lost (unrecovered) economic activity as a result of the Project. Revolution Wind must submit to BOEM a report that includes 1) a description of the structure of the fund and its consistency with BOEM's draft guidance and 2) an analysis of the impacts of the Project on shoreside businesses for review and comment. Revolution Wind must then submit to BOEM evidence of the implementation of the Fund, including the following: A description of any implementation details not covered in the report to BOEM regarding the mechanism established to compensate for losses to commercial and for-hire recreational fishermen and related shoreside businesses resulting from all	This measure, if adopted, would reduce economic impacts to shoreside businesses engaged in commercial and for-hire recreational fisheries.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	phases of the project development on the Lease Area (preconstruction, construction, operation, and decommissioning) The Direct Compensation Fund charter, including the governance structure, audit and public reporting procedures, and standards for paying compensatory mitigation for impacts to fishers and related shoreside businesses from lease area development Documentation regarding the funding account, including the dollar amount, establishment date, financial institution, and owner of the account	

3.9.2.6.1 Measures Incorporated into the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.9-29 and in Appendix F, Table F-2, are incorporated into Alternative G (Preferred Alternative). These measures, if adopted, would further define how the effectiveness and enforcement of EPMs would be ensured and improve accountability for compliance with EPMs by requiring the submittal of analyses and plans for approval by the enforcing agency(ies) and by defining reporting requirements. Because these measures ensure the effectiveness of and compliance with EPMs that are already analyzed as part of the Preferred Alternative, implementation of these measures would not further reduce the impact level of the Preferred Alternative from what is described in Section 3.9.2.5.

3.10 Cultural Resources

The Cultural Resources section addresses marine and terrestrial archaeological resources and visually sensitive cultural resources located within the viewshed of Project elements, also referred to as viewshed resources. All other visual (non-historic) resources are addressed in Section 3.20. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties on identified cultural resources, adverse effects, and the resolution of adverse effects.[27] The Project constitutes an undertaking under NHPA Section 106. BOEM is using the NEPA process to substitute for the NHPA Section 106 process on this undertaking, in accordance with the Section 106 implementing regulations, 36 CFR 800, and pursuant to 36 CFR 800.8(c) (see also CEQ and ACHP 2013 and ACHP 2020). The Cultural Resources section discusses potential impacts on cultural resources from the Project, alternatives, and ongoing and planned activities in the cultural resources GAA.

Geographic Analysis Area: The combined GAA for cultural resources (marine, terrestrial, and viewshed), as shown in Figures 3.10-1 through 3.10-4, is equivalent to the Project's area of potential effects (APE), as defined in the Section 106 regulations. In 36 CFR 800.16(d), the APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alteration in the character or use of historic properties," or cultural resources that are eligible for the National Register of Historic Places (NRHP), "if any such properties exist." BOEM (2020a) and in Appendix J defines the Project APE as

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

Table E2-9 in Appendix E1 summarizes baseline conditions and impacts to cultural resources, based on IPFs assessed and that would arise from ongoing activities, future non-offshore wind activities, and offshore wind activities.

The phrase *cultural resources* refers to archaeological sites, buildings, structures, objects, and districts, which may include cultural landscapes and traditional cultural places (TCPs). These resources may be historic properties as defined in 36 CFR 800.16(l) and may be listed on national, state, or local historic registers or be identified as being important to a particular group during consultation. Federal, state, and local regulations recognize the public's interest in cultural resources. Many of these regulations, including NEPA and the NHPA, require a project to consider how it might significantly affect cultural resources.

[27] The term "adverse" has a specific meaning under NHPA Section 106 regulations (in 36 CFR 800.5) and, therefore, to remove confusion in the Cultural Resources section, the terms "negative" and "beneficial" are used in the identification of impacts under NEPA.

3.10.1 Description of the Affected Environment and Environmental Consequences of the No Action Alternative for Cultural Resources

This section discusses baseline conditions in the GAA for cultural resources as described in the COP, COP Appendices M, N, and U2, and supplemental cultural resources studies (i.e., EDR 2021a, 2022, 2023a; Forrest and Waller 2023; Revolution Wind 2022; SEARCH 2023). Specifically, this includes terrestrial and offshore areas potentially affected by the proposed Project's land- or seafloor-disturbing activities, areas where structures from the Project would be visible, and the area of intervisibility where structures from both the Project and future offshore wind projects would be visible simultaneously.

Revolution Wind has conducted onshore and offshore cultural resources investigations to identify known and previously unidentified cultural resources within the marine cultural resources, terrestrial cultural resources, and viewshed resources portions of the APE. Table 3.10-1 presents an archaeological summary of the pre-Contact period and post-Contact period cultural context of Rhode Island, Massachusetts, and surrounding areas (Forrest and Waller 2023).

Table 3.10-1. Cultural Resources Context for Rhode Island, Massachusetts, and Surrounding Areas

Period		Years Before Present (B.P.)
Pre-Contact	Ancient (Paleoindian)	13,500–11,000
	Archaic	11,000–3000
	Early Archaic	11,000–9000
	Middle Archaic	9000–6000
	Late Archaic	6000–3000
	Transitional Archaic	3900–2500
	Woodland	3000–450
	Early Woodland	3000–1600
	Middle Woodland	1600–1000
	Late Woodland	1000–450
Post-Contact	Native American, colonial, and U.S. cultural history	450–0

<u>Marine cultural resources review</u>: A marine archaeological resources assessment (MARA) is in COP Appendix M.[28] The MARA identified 32 submerged marine cultural resources (SEARCH 2023). Nineteen of these are post-Contact historic shipwrecks or possible shipwrecks. Thirteen are geomorphic features of ancient submerged landforms. These features consist of discrete and discontinuous locations that may contain preserved evidence of formerly terrestrial landscape features that have survived erosion during the Ancient to Archaic periods of seashore submersion, known as marine transgression, that proceeded over a time frame of several thousand years after the recession of glaciers at the end of the Pleistocene epoch or last Ice Age. Geomorphic features derive their significance from their archaeological

[28] The content of COP Appendix M contains sensitive information and is not available for public review, but a redacted version and non-technical summary are available on BOEM's website: https://www.boem.gov/renewable-energy/state-activities/revolution-wind-farm-construction-and-operations-plan.

potential and potential connections to Native American lifeways, such as their potential for pre-Contact cultural resources and their contribution to a broader culturally significant landscape.

Terrestrial cultural resources review: A terrestrial archaeological resources assessment (TARA) is in COP Appendix N.[29] The TARA identified four terrestrial cultural resources through Phase I archaeological surveys (Forrest and Waller 2023), which is the initial investigation phase of archaeological survey. These terrestrial cultural resources include a Native American encampment dating to the Archaic and Woodland periods, a Native American encampment with stone tool manufacturing waste materials dating to the Late Archaic or perhaps Early Woodland period, a pre-Contact low density locus of chipped stone manufacture, and a pre-Contact isolated quartz flake produced by stone working.

Viewshed resources review: Two historic resources visual effects assessments (HRVEA) are included in COP Appendix U,[30] one for the viewshed of the onshore Project components and another for the viewshed of the offshore Project components. For the onshore HRVEA, viewshed analyses determined that two viewshed resources—both of which contain historic buildings and structures—are within the viewshed APE (EDR 2021a). From 451 viewshed resources identified in the viewshed APE within the offshore HRVEA (including 12 National Historic Landmarks [NHLs]), viewshed analyses found 101 aboveground viewshed resources with the potential to be negatively affected from a moderate to major degree in the viewshed APE (EDR 2023a). These moderate to major impacts would rise to a level of adverse effects under the NHPA Section 106 criteria at 36 CFR 800. These 101 viewshed resources consist of two TCPs and 99 historic buildings, structures, or districts (including five NHLs[31]).

3.10.1.1 Marine Cultural Resources

Geographic analysis area: BOEM (2020a) defines the APE for the marine cultural resources GAA (hereafter marine APE) as the depth and breadth of the seafloor potentially impacted by bottom-disturbing activities by the Project (see Figure 3.10-1).

[29] The content of COP Appendix N contains sensitive information and is not available for public review, but a redacted version and non-technical summary are available on BOEM's website: https://www.boem.gov/renewable-energy/state-activities/revolution-wind-farm-construction-and-operations-plan.

[30] The content of COP Appendix U contains sensitive information and is not available for public review, but a redacted version and non-technical summary are available on BOEM's website: https://www.boem.gov/renewable-energy/state-activities/revolution-wind-farm-construction-and-operations-plan.

[31] The National Park Service (NPS), which administers the NHL program for the Secretary of the Interior (Secretary), describes NHLs and the requirements for NHLs as follows: "National Historic Landmarks (NHL) are designated by the Secretary under the authority of the Historic Sites Act of 1935, which authorizes the Secretary to identify historic and archaeological sites, buildings, and objects which 'possess exceptional value as commemorating or illustrating the history of the United States.' Section 110(f) of the NHPA requires that Federal agencies exercise a higher standard of care when considering undertakings that may directly and adversely affect NHLs. The law requires that agencies, 'to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to such landmark.' In those cases when an agency's undertaking directly and adversely affects an NHL, or when Federal permits, licenses, grants, and other programs and projects under its jurisdiction or carried out by a state or local government pursuant to a Federal delegation or approval so affect an NHL, the agency should consider all prudent and feasible alternatives to avoid an adverse effect on the NHL. (NPS 2021)

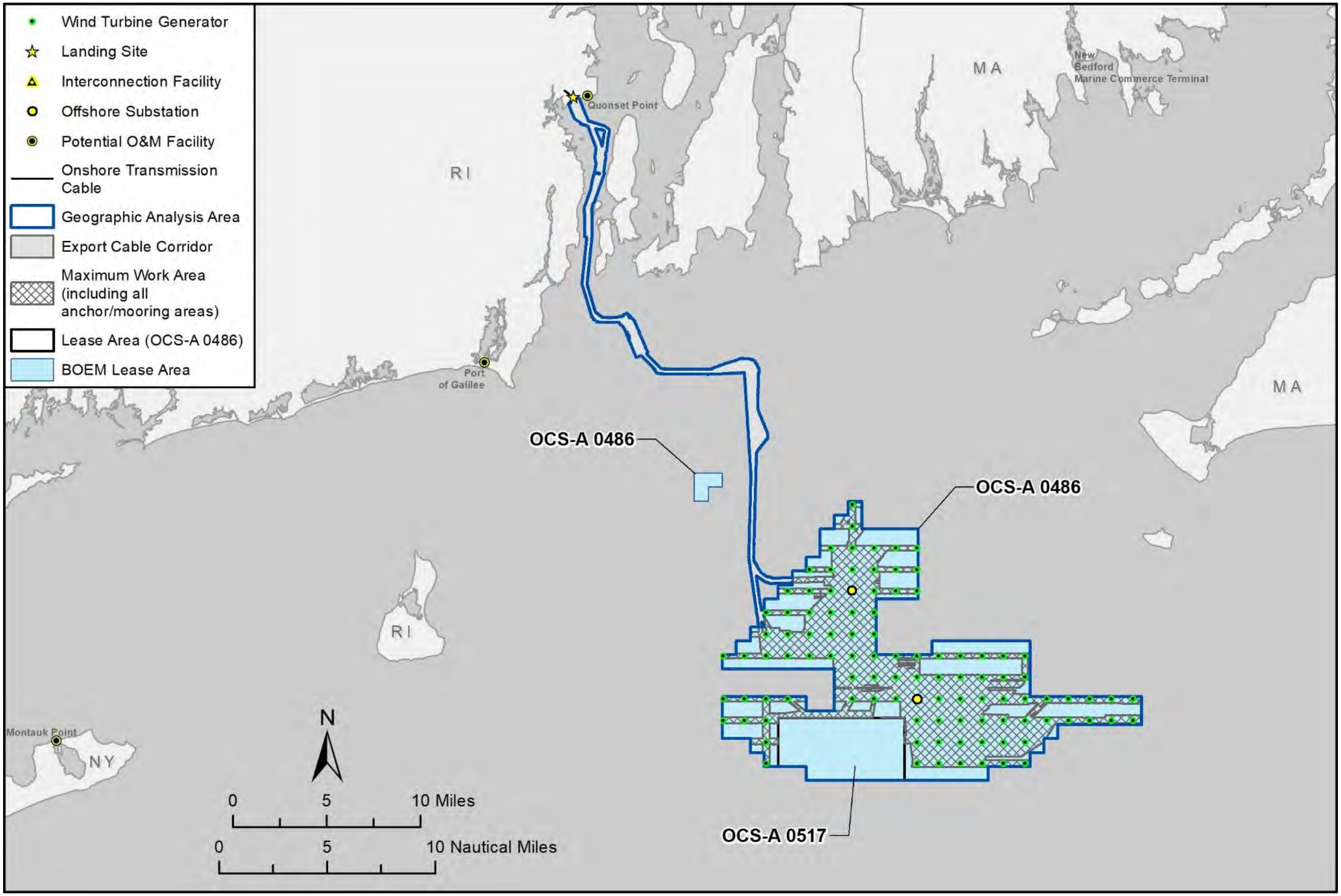

Figure 3.10-1. Marine cultural resources geographic analysis area.

Affected environment: The MARA was conducted on the marine APE between 2017 and 2020 (SEARCH 2023). The high-resolution geotechnical data collected during the marine archaeological survey was used for the geoarchaeological analysis (SEARCH 2023). The survey resulted in the identification of 32 targets of interest within the RWF and RWEC, 19 of which are potential submerged archaeological marine resources and 13 of which are geomorphic features of archaeological interest, associated with ancient submerged landforms (SEARCH 2023). Sixteen of the potential submerged marine cultural resources are located in the RWF and three are located in the RWEC. Five of the geomorphic features of archaeological interest are located in the RWF and eight are located in the RWEC.

The 19 potential submerged archaeological marine cultural resources are shipwrecks or possible historic shipwrecks or sunken craft (Table 3.10-2). These shipwrecks may be NRHP-eligible cultural resources, pursuant to 36 CFR 800.16(l), eligible for their potential to contribute important information to archaeological research under NRHP Criterion D at minimum. Any of these resources that are sunken military craft also remain the sovereign property of the U.S. government, subject to the protections of Public Law 108–375 Title XIV—Sunken Military Craft, administered by the Department of the Navy under an overall policy of leaving these crafts and associated remains in place and undisturbed.

The geomorphic features are discrete and discontinuous locations of ancient submerged landforms that may contain preserved evidence of formerly terrestrial landscapes that have survived erosion during marine transgression (Table 3.10-3). Although these features exhibit archaeological potential; no cultural materials associated with the ancient submerged landform features were identified in core samples taken during the submerged cultural resources investigation (SEARCH 2023). These features may derive their significance from reasons other than their archaeological potential, however, such as their potential contribution to a broader culturally significant landscape. Ancient submerged landforms are marine cultural resources of importance to Native American tribes, NRHP eligible at minimum for their connection to broad events within tribal history under NRHP Criterion A and for their ability to contribute further information to the understanding of that history under NRHP Criterion D pursuant to 36 CFR 800.16(l) (SWCA 2021).

Table 3.10-2. Shipwreck Archaeological Sites Identified within the Marine Cultural Resources Geographic Analysis Area

Remote Sensing Target	Location	Target Dimensions (m)	Description
Target 01	RWF	24 × 3.9 × 1.4	Shipwreck
Target 02	RWF	27 × 20 × 0.7	Possible historic shipwreck
Target 03	RWF	7.2 × 0.8 × 0.4	Possible historic shipwreck
Target 04	RWF	3.8 × 2.3 × 0.5	Possible historic shipwreck
Target 05	RWF	Not available (magnetic anomaly)	Possible historic shipwreck
Target 06	RWF IAC	30 × 15 × 1.4	Shipwreck
Target 07	RWF IAC	Not available (magnetic anomaly)	Possible historic shipwreck
Target 08	RWF IAC	28 × 15 × 0.8	Shipwreck
Target 09	RWF IAC	41 × 37 × 1.4	Shipwreck

Remote Sensing Target	Location	Target Dimensions (m)	Description
Target 10	RWF IAC	Not available (magnetic anomaly)	Possible historic shipwreck
Target 11	RWEC	24 × 8.8 × 0.3	Shipwreck
Target 13	RWEC	39 × 15 × 0.6	Possible historic shipwreck
Target 14	RWEC	Not available (magnetic anomaly)	Possible historic shipwreck
Target 15	RWF	Not available (magnetic anomaly)	Possible historic shipwreck
Target 16	RWF IAC	Not available (magnetic anomaly)	Possible historic shipwreck
Target 17	RWF	Not available (magnetic anomaly)	Possible historic shipwreck
Target 18	RWF	Not available (magnetic anomaly)	Possible historic shipwreck
Target 19	RWF IAC	34 × 12 × 1.0	Possible historic shipwreck
Target 20	RWF	16 × 5.5 × 4.5	Possible historic shipwreck

Source: SEARCH (2023:Table 4-1).

Note: No dimensions are available for targets identified on the basis of a magnetic signature. "Target-12" was a probable bridge and not included on that basis. Also, mapped marine resource locations (SEARCH 2023) contain sensitive information and are not publicly distributed.

Table 3.10-3. Geomorphic Features Identified within the Marine Cultural Resources Geographic Analysis Area

Geomorphic Feature ID	Location	Description
Target 21	RWEC-RI	Paleochannel with preserved flanks
Target 22	RWEC-RI	Paleochannel with preserved flanks
Target 23	RWEC OCS	Paleochannel with preserved flanks
Target 24	RWF	Paleochannel with preserved flanks
Target 25	RWF	Paleochannel with preserved flanks
Target 26	RWF	Paleochannel with preserved flanks
Target 27	RWF	Paleochannel with preserved flanks
Target 28	RWF	Paleochannel with preserved flanks
Target 29	RWEC-RI	Paleochannel with preserved flanks
Target 30	RWEC-RI	Paleochannel with preserved flanks
Target 31	RWEC-RI	Paleochannel with preserved flanks
Target 32	RWEC-RI	Paleochannel with preserved flanks
Target 33	RWEC-RI	Paleochannel with preserved flanks

Source: SEARCH (2023:Table 4-2).

Note: Mapped ancient submerged landform extents and locations (SEARCH 2023) contain sensitive information and are not publicly distributed.

The Project and other ongoing and reasonably foreseeable activities would result in an adverse effect when it alters, directly or indirectly, any of the characteristics of a marine cultural resource that qualify the resource for the NRHP in a manner that would diminish the integrity of the NRHP-eligible marine cultural resource's location, design, setting, materials, workmanship, feeling, or association per 36 CFR 800.5(a)(1). Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5(a)(1)). NRHP-eligible shipwrecks and ancient submerged landforms would be susceptible to adverse effects from physical destruction of or damage to the historic property by the Project or other ongoing and reasonably foreseeable activities (36 CFR 800.5(a)(2)(i)). Impacts to NRHP-eligible cultural resources that are determined to be **moderate** or **major** as defined in this EIS would rise to the level of adverse effect per the criteria of adverse effect under NHPA Section 106. Impacts to cultural resources that are determined to be **negligible** or **minor** as defined in this EIS would not rise to the level of adverse effects under the criteria of adverse effect under NHPA Section 106.

3.10.1.2 Terrestrial Cultural Resources

<u>Geographic analysis area:</u> BOEM (2020a) defines the APE for the terrestrial cultural resources GAA (or terrestrial APE) as the depth and breadth of terrestrial areas potentially impacted by any ground-disturbing activities by the Project. This includes the areas of the OnSS, ICF, onshore transmission cable corridor, and landfall envelope depicted in Figure 3.10-2.

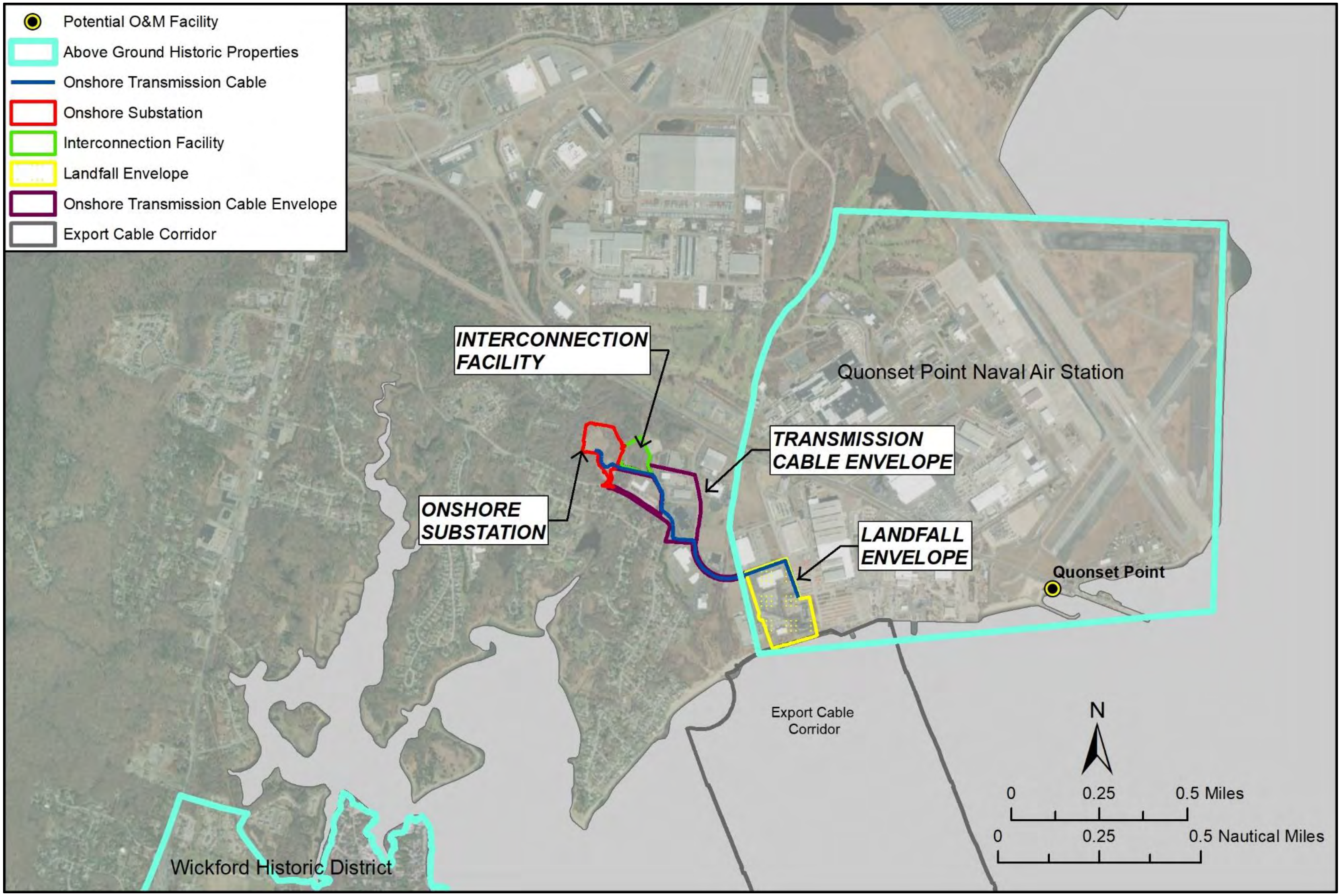

Figure 3.10-2. Terrestrial cultural resources geographic analysis area.

Affected environment: The TARA was conducted within the onshore Project components of the onshore transmission cable, landfall work area, and the OnSS and ICF in 2021 (Forrest and Waller 2023) (see Figure 3.10-2). Construction of onshore Project components could affect terrestrial cultural resources through physical disturbance.

Construction of the OnSS and ICF would collectively require temporary disturbance of approximately 10.9 acres. The maximum depth of disturbance within the OnSS and ICF work area limits is 60 feet. The width of potential ground disturbance for the onshore transmission cable is assumed to be at the extent of the Project easement, which is 25 feet wide centered along the cable route. The preferred onshore transmission cable route is an approximately 1-mile route that will predominantly follow along paved roads or previously disturbed areas such as parking lots. There are alternative onshore transmission cable routes under consideration within the onshore transmission cable envelope as depicted on Figure 3.10-2. Some of the routes under consideration have segments that would be installed in undeveloped vegetated areas, although they would mostly be installed within paved roads and parking lots (as with the preferred onshore transmission cable route) and would be approximately the same length. Project-related ground disturbance may extend to a maximum depth of 13 feet anywhere within the width of this corridor. Revolution Wind is considering a range of siting options for the RWEC landfall, all of which are encompassed by a 20-acre landfall work area. Within this landfall area, 3.1-acres would be sited, within which ground disturbance associated with the onshore transmission cable construction would occur. As noted above, a preferred route for the onshore transmission cable has been proposed; however, Revolution Wind is considering alternative routing of the onshore transmission cable within the onshore transmission cable envelope, which totals 16.7 acres. Installation of the onshore transmission cable will impact approximately 3.1 acres; therefore, only a portion of the 16.7-acre onshore transmission cable envelope will actually be impacted by installation of the onshore transmission cable. The deepest disturbances within the landfall work area would be associated with the HDD construction method for cable emplacement, which may entail the installation of temporary sheet pile anchor walls driven to a depth of approximately 20 feet. The HDD drill itself may reach a depth of up to 66 feet between the onshore TJBs and the offshore exit pits, but the sediment displacement would be largely confined to the two 3-foot-diameter bore holes. Quonset Point is in an area of concentrated Narragansett Indian settlement specifically associated with the Contact period and extending to the west and southwest of the terrestrial APE (Forrest and Waller 2023). Construction, operation, decommissioning, and large-scale redevelopment of former military facilities at Quonset Point substantially altered the local landscape. Most of the terrestrial APE has been substantially altered by development, demolition, remediation, and associated grading activities postdating 1941. Intact pockets of natural soils represent a small percentage of all surficial earth. The proposed OnSS site was used as a general dump site during naval operations (1940s through 1960s); several hundred tons of debris and soil were removed during remediation activities in the late 1990s. The pockets of relatively intact natural soils within the terrestrial APE are located within the OnSS and ICF work area limits and along the southern margins of the landfall area (Forrest and Waller 2023).

The Public Archaeology Laboratory, Inc. (PAL) contacted the Rhode Island Historic Preservation and Heritage Commission (RIHPHC) and the Narragansett Indian Tribe, Wampanoag Tribe of Gay Head (Aquinnah), Mashpee Wampanoag, Mashantucket (Western) Pequot Tribal Nation, and Mohegan Tribal Historic Preservation Offices (THPOs) to consider and address tribal concerns within their Phase I survey investigation. Results of the Phase I survey of potentially undisturbed, buried portions of the OnSS and ICF

APE by PAL (Forrest and Waller 2023) resulted in the identification of four archaeological resources. PAL did not conduct remote sensing (ground penetrating radar, soil resistivity, magnetometry, or similar techniques). Dense surface vegetation made remote sensing impractical, and twentieth-century dumping, filling, and other ground disturbances and landscape modifications would have produced inconclusive results. The RIHPHC also does not recognize remote sensing as a reliable method for archaeological site identification, preferring ground-truthing instead to include the excavation of test pits or other excavation units.

The Phase I survey resulted in the identification of two archaeological sites within the OnSS work area limits and one archaeological site and one isolated artifact within the ICF work area limits, named the Quonset Substation archaeological site, the Mill Creek Swamp #1 archaeological site, the Mill Creek Swamp #2 archaeological site, and the QDC Find Spot artifact, respectively (Forrest and Waller 2023). In the OnSS work area limits, the Mill Creek Swamp #1 archaeological site and the Mill Creek Swamp #2 archaeological site are eligible for the NRHP under Criterion D and are archaeologically important (Table 3.10-4). Revolution Wind is committed to avoiding or minimizing impacts to these sites to the best extent feasible. If final OnSS and ICF construction design plans result in impacts to these sites, Revolution Wind will consult with BOEM, other federal and state agencies, and Native American tribes to develop and implement an archaeological mitigation/treatment plan to resolve adverse effects that Project construction would have on the Mill Creek Swamp #1 and Mill Creek Swamp #2 sites. In the ICF work area limits, the Quonset Substation archaeological site is a low-density lithic scatter and the QDC Find Spot artifact is an isolated quartz flake; both resources are not eligible for the NRHP and are not archaeologically important.

Based on data collected during PAL's archaeological monitoring of geotechnical test pits and the Phase I survey at the OnSS and ICF (Forrest and Waller 2023), PAL found that route options within the onshore transmission cable envelope area lack stratigraphic integrity and were determined to not be archaeologically sensitive. Thus, PAL does not recommend further archaeological testing for the potential alternative routing of the onshore transmission cable identified in November 2021.

Table 3.10-4. Terrestrial Cultural Resources within the Terrestrial Cultural Resources Geographic Analysis Area

Terrestrial Cultural Resources	Portion of Project	NRHP Eligibility
Mill Creek Swamp #1	OnSS work area limits	Eligible
Mill Creek Swamp #2	OnSS work area limits	Eligible
Quonset Substation	ICF work area limits	Not eligible
QDC Find Spot artifact	ICF work area limits	Not eligible

Source: Forrest and Waller (2023).

Terrestrial cultural resources, especially archaeological sites, when NRHP eligible, tend to be eligible under Criterion D for their potential to contribute further information important to understanding history. Those that are TCPs, when present, tend to further be eligible under NRHP Criterion A for their important contributions to broad events in tribal history, Criterion B for their connection to important figures in tribal history, and/or Criterion C for their distinctive characteristics of composition.

The Project and other ongoing and reasonably foreseeable activities would result in an adverse effect when it alters, directly or indirectly, any of the characteristics of a terrestrial cultural resource that qualify the resource for the NRHP in a manner that would diminish the integrity of the NRHP-eligible terrestrial cultural resource's location, design, setting, materials, workmanship, feeling, or association per 36 CFR 800.5(a)(1). Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5(a)(1)). NRHP-eligible terrestrial cultural resources, including TCPs, would be susceptible to adverse effects from physical destruction of or damage to the resource by the Project or other ongoing and reasonably foreseeable activities (36 CFR 800.5(a)(2)(i)). Impacts to NRHP-eligible cultural resources that are determined to be **moderate** or **major** as defined in this EIS would rise to the level of adverse effect per the criteria of adverse effect under NHPA Section 106. Impacts to cultural resources that are determined to be **negligible** or **minor** as defined in this EIS would not rise to the level of adverse effects under the criteria of adverse effect under NHPA Section 106.

3.10.1.3 Viewshed Resources

Geographic analysis area: This section addresses cultural resources located within the viewshed of Project elements. The viewshed includes the onshore and offshore visual effects assessment GAA. The cultural resources within the viewshed, which are typically aboveground historic properties, are referred to herein as viewshed resources. All other visual resources are addressed in Section 3.20.

BOEM defines the APE for visual impact analysis (hereafter the viewshed APE) as the geographic areas from which the offshore and onshore Project components could be seen. Onshore Project components where new development would occur have a viewshed radius of 3 miles around the ICF and OnSS (Figure 3.10-3). The onshore transmission cable and ICF interconnection ROW will be buried, without potential for enduring visual impacts to cultural resources. Onshore components where redevelopment of existing facilities could occur have a viewshed radius of 1 mile around O&M facilities at the Port of Davisville at Quonset Point and Port Robinson (see Figure 3.10-3). However, the 1-mile radius at the Davisville-Quonset Point O&M facility is completely subsumed within the 3-mile radius around the ICF and OnSS. Offshore Project components (e.g., WTGs) have a much larger viewshed radius of 40 miles around the edge of the Lease Area (Figure 3.10-4). The 1-mile, 3-mile, and 40-mile radii represent the maximum limit of theoretical visibility for each respective onshore or offshore Project component; however, these radii do not define the viewshed APE. Within these radii, the APE for viewshed resources is defined by those geographic areas only with a potential visibility of Project components and excludes areas with obstructed views of Project components. Visibility and views of Project components were determined through a viewshed analysis (EDR 2021a, 2023a; Revolution Wind 2022). The viewshed analysis applied GIS modeling to take into account the true visibility of the Project (e.g., visual barriers such as topography, vegetation, and non-historic structures that obstruct the visibility of Project components) (EDR 2021a, 2023a) (see Figures 3.10-3 and 3.10-4).

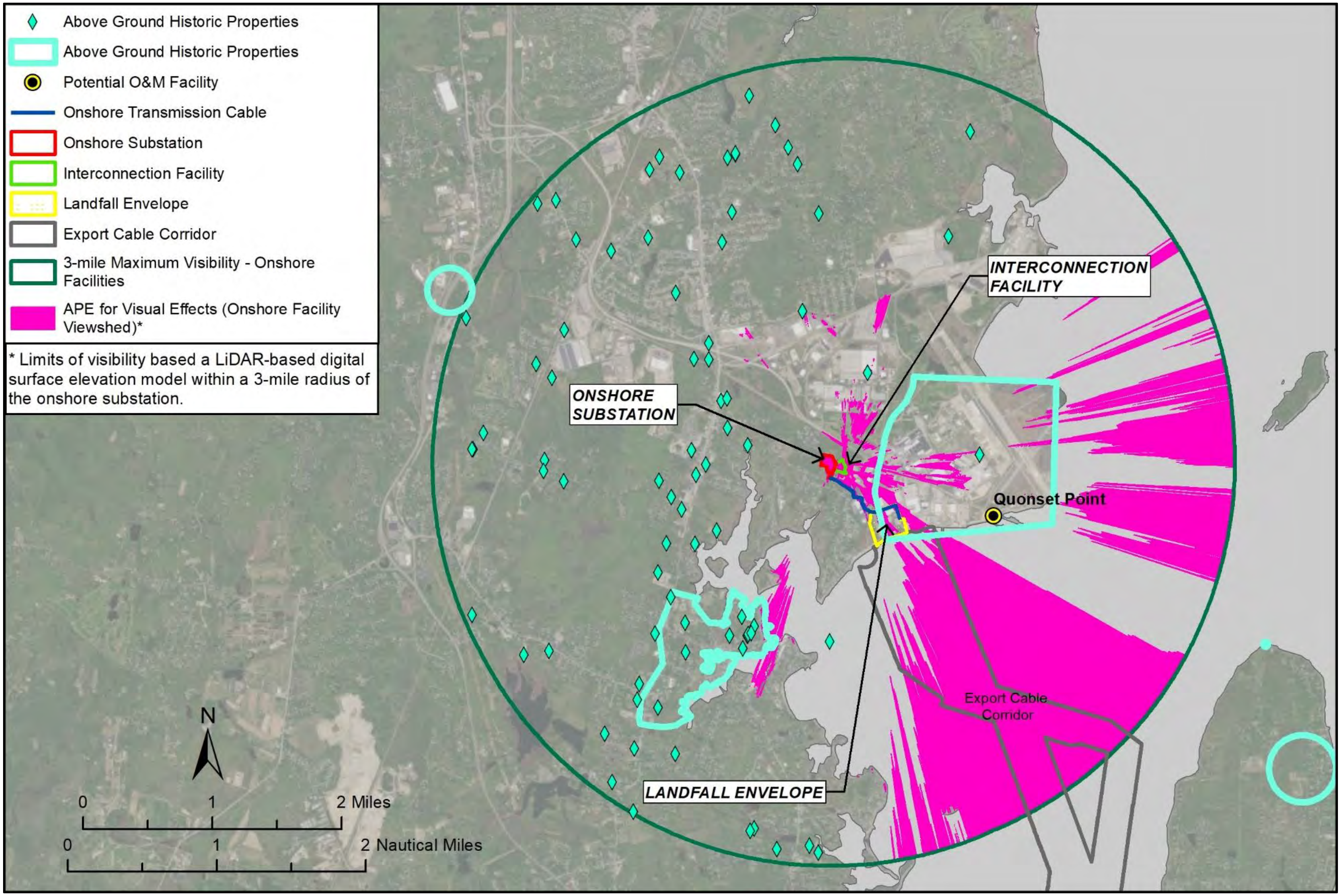

Figure 3.10-3. Viewshed area of potential effects and visual effects assessment geographic analysis area – onshore.

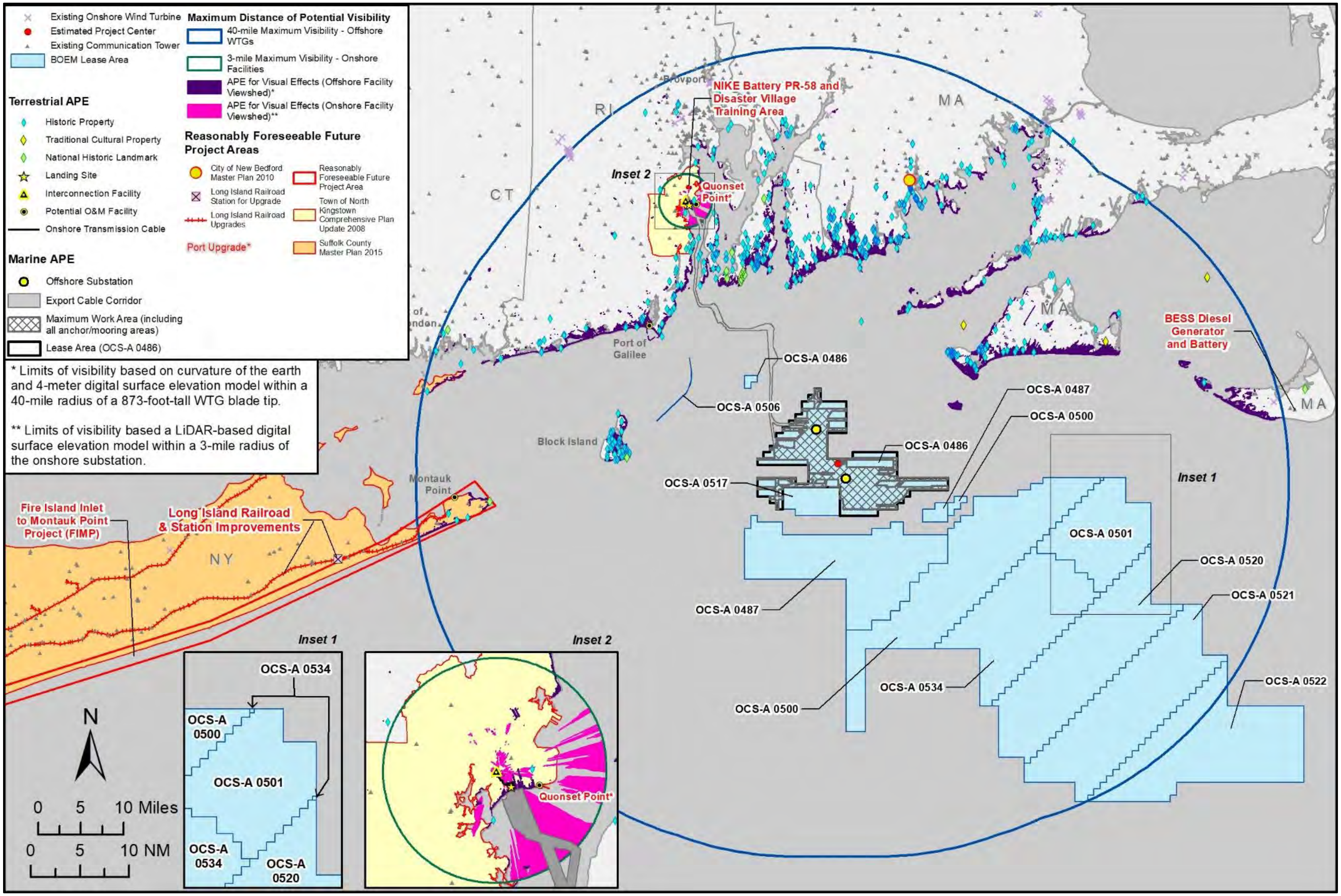

Figure 3.10-4. Viewshed area of potential effects and visual effects assessment geographic analysis area – offshore.

Affected environment: For the onshore components viewshed, the HRVEA identified a total of 80 aboveground viewshed resources, within 3 miles of the proposed OnSS and ICF, that consist of 16 NRHP-listed properties, two properties that have been determined by the RIHPHC to be eligible for the NRHP, nine properties included in the RIHPHC inventory but without formal determinations of NRHP eligibility, and 53 Rhode Island Historical Cemeteries Commission–identified Rhode Island Historical Cemeteries (EDR 2021a). Viewshed analyses determined that of these 80 viewshed resources, two are within the viewshed APE (see Figure 3.10-3 and Table 3.10-5). These two resources are located within the viewshed of the OnSS and ICF. The viewshed analysis determined that neither are within the viewshed of any of the five potential O&M facility locations. At 1.1 miles away from the OnSS and ICF location is the NRHP-listed Wickford Historic District; at 0.25 mile away is the Quonset Point Naval Air Station, determined by the State of Rhode Island to be NRHP eligible (EDR 2021a).

Table 3.10-5. National Register of Historic Places–Eligible and Listed Resources within the Viewshed Area of Potential Effects for Onshore Development

Visually Sensitive Resource	Distance to OnSS and ICF (miles)
Wickford Harbor/Wickford Village	1.0
Quonset Point Naval Air Station	0.25

Source: EDR (2023b).

In relation to the offshore Project components, the HRVEA identified a total of 451 aboveground viewshed resources within the viewshed APE that consist of 98 NRHP-listed properties, 73 properties that have been determined eligible for the NRHP, 280 properties included in the RIHPHC and the Massachusetts Historical Commission (MHC) historic inventories but without formal determinations of NRHP eligibility (EDR 2023a; Revolution Wind 2022). Those viewshed resources without formal determinations of NRHP eligibility are treated as NRHP-eligible cultural resources for the purposes of this analysis and compliance with NHPA Section 106.

Twelve of the 98 NRHP-listed viewshed resources are also NHLs (EDR 2022, 2023a). These are the Montauk Point Lighthouse, Block Island Southeast Lighthouse, Original U.S. Naval War College Historic District, Fort Adams Historic District, Battle of Rhode Island Historic District, Nantucket Historic District, New Bedford Historic District, Ocean Drive Historic District, Bellevue Avenue Historic District, The Breakers, Marble House, and William Watts Sherman House. BOEM's finding of adverse effects document in Appendix J provides further context on NHLs and the supplemental report *Revolution Wind Farm National Historic Landmarks* provides further detail on the 12 NHLs named here (EDR 2022).

Three resources in Massachusetts and extending to the OCS were documented specifically due to their categorization as TCPs, and these consist of the Nantucket Sound TCP, the Chappaquiddick Island TCP, and the Vineyard Sound and Moshup's Bridge TCP. Each of these three resources is represented by broad, complex cultural landscapes and connected seascapes (EDR 2023a). Examples of these include that, historically, much of the fishing by the region's Native American tribes was concentrated in nearshore marine and estuarine environments (Bennett 1955); recent BOEM consultation with Native American tribes in lease areas adjacent to the Project indicate that tribal subsistence fisheries continue to occur predominately in inshore areas (BOEM 2020b), and typical recreational fishing locations in the area are close to shore (within 1 mile of the coast) (see Section 3.18). The Nantucket Sound TCP is NRHP listed and the Chappaquiddick Island TCP and the Vineyard Sound and Moshup's Bridge TCP have previously been determined NRHP eligible by BOEM. BOEM's finding of adverse effects document in Appendix J provides further context on TCPs and the offshore HRVEA (COP Appendix U[32]) provides further TCP details.

For the offshore components, viewshed analyses for the WTGs and OSSs identified 451 cultural resources that may be eligible for the NRHP. Of these, 101 in the viewshed APE would be subject to potential moderate to major impacts from the Project, rising to the level of adverse effect under the NHPA Section 106 criteria for adverse effects (36 CFR 800.5). NRHP-eligible viewshed resource distribution is mapped on Figure 3.10-4. This analysis assessed the visibility of a WTG from the water level to the tip of an upright rotor blade at a height of 873 feet and further considered how distance and curvature of the Earth affect visibility as space between the viewing point and WTGs increases. The analysis further considered the nighttime lighting of offshore structures during their construction. Of the 101 resources in the viewshed APE that could be susceptible to moderate to major negative visual impacts from the offshore components of the Project, 37 are listed on the NRHP (five of which are also NHLs), 33 have been determined eligible for the NRHP, 31 are included in the RIHPHC and MHC historic inventories but without formal determinations of NRHP eligibility. Two of the cultural resources susceptible to moderate to major negative visual impacts within the viewshed APE are NRHP-eligible TCPs. Table 3.10-6 presents the 101 viewshed resources by order of distance to the nearest Project WTG.

Table 3.10-6. Aboveground Historic Properties where Moderate to Major Visual Impacts Would Potentially Result in Adverse Effects under NHPA Section 106 Criteria

Visually Sensitive Resource	Municipality	County	State	Resource Designation	Distance to nearest WTG (miles)
Vineyard Sound and Moshup's Bridge	Aquinnah	Dukes	MA	NRHP-eligible resource (BOEM determined)	5
Sakonnet Light Station	Little Compton	Newport	RI	NRHP-listed resource	12.7
Warren Point HD	Little Compton	Newport	RI	NRHP-eligible resource (RIHPHC determined)	12.9
Abbott Phillips House	Little Compton	Newport	RI	RIHPHC historic resource	13.0
Flaghole	Chilmark	Dukes	MA	MHC historic inventory site	13.3
Stone House Inn	Little Compton	Newport	RI	NRHP-listed resource	13.4
Simon Mayhew House	Chilmark	Dukes	MA	MHC historic inventory site	13.5
71 Moshup Trail	Aquinnah	Dukes	MA	MHC historic inventory site	13.7
Vanderhoop, Edwin DeVries Homestead	Aquinnah	Dukes	MA	NRHP-listed resource	13.7

[32] The content of COP Appendix U contains sensitive information and is not available for public review, but a redacted version and non-technical summary are available on BOEM's website: https://www.boem.gov/renewable-energy/state-activities/revolution-wind-farm-construction-and-operations-plan.

Visually Sensitive Resource	Municipality	County	State	Resource Designation	Distance to nearest WTG (miles)
Gay Head - Aquinnah Shops Area	Aquinnah	Dukes	MA	MHC historic inventory site	13.7
Flanders, Ernest House, Shop, and Barn	Aquinnah	Dukes	MA	MHC historic inventory site	13.8
3 Windy Hill Drive	Aquinnah	Dukes	MA	MHC historic inventory site	13.9
Gay Head Light	Aquinnah	Dukes	MA	NRHP-listed resource	13.9
Tom Cooper House	Aquinnah	Dukes	MA	MHC historic inventory site	14
Leonard Vanderhoop House	Aquinnah	Dukes	MA	MHC historic inventory site	14
Theodore Haskins House	Aquinnah	Dukes	MA	MHC historic inventory site	14.1
Gay Head - Aquinnah Coast Guard Station Barracks	Aquinnah	Dukes	MA	MHC historic inventory site	14.1
Gay Head - Aquinnah Town Center HD	Aquinnah	Dukes	MA	NRHP-listed resource	14.2
Gooseneck Causeway	Westport	Bristol	MA	MHC historic inventory site	14.8
Gooseberry Neck Observation Towers	Westport	Bristol	MA	MHC historic inventory site	14.8
Spring Street	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	14.9
Capt. Mark L. Potter House	New Shoreham	Washington	RI	RIHPHC historic resource	14.9
Tunipus Goosewing Farm	Little Compton	Newport	RI	NRHP-eligible resource (RIHPHC Determined)	15
WWII Lookout Tower – Spring Street	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.1
Westport Harbor	Westport	Bristol	MA	MHC historic inventory site	15.2
Bellevue Avenue HD	Newport	Newport	RI	NHL	15.2
Block Island Southeast Lighthouse NHL	New Shoreham	Washington	RI	NHL	15.2
New Shoreham HD	New Shoreham	Washington	RI	Local Historic	15.3
Spring Cottage	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.3
Old Harbor Hist Dist.	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.3

Visually Sensitive Resource	Municipality	County	State	Resource Designation	Distance to nearest WTG (miles)
Capt. Welcome Dodge Sr.	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.3
Caleb W. Dodge Jr. House	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.3
Spring House Hotel	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.4
Pilot Hill Road and Seaweed Lane	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.4
Ocean Drive HD	Newport	Newport	RI	NHL	15.7
Marble House	Newport	Newport	RI	NHL	15.7
Ochre Point – Cliffs HD	Newport	Newport	RI	NRHP-listed resource	15.8
WWII Lookout Tower at Sands Pond	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.8
Sea View Villa	Middletown	Newport	RI	RIHPHC historic resource	15.9
Rosecliff/Oelrichs (Hermann) House/ Mondroe (J. Edgar) House	Newport	Newport	RI	NRHP-listed resource	15.9
The Breakers	Newport	Newport	RI	NHL	15.9
Corn Neck Road	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	15.9
Clam Shack Restaurant	Westport	Bristol	MA	MHC historic inventory site	15.9
Horseneck Point Lifesaving Station	Westport	Bristol	MA	MHC historic inventory site	15.9
Whetstone	Middletown	Newport	RI	RIHPHC historic resource	16.0
The Bluff/John Bancroft Estate/ Purgatory Chasm	Middletown	Newport	RI	NRHP-eligible resource (RIHPHC determined)	16.0
Clambake Club Of Newport	Middletown	Newport	RI	NRHP-listed resource	16.0
Old Town and Center Roads	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.0
Beach Avenue	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.1
Mitchell Farm	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.1

Visually Sensitive Resource	Municipality	County	State	Resource Designation	Distance to nearest WTG (miles)
Indian Head Neck Road	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.4
Westport Point Revolutionary War Properties	Westport	Bristol	MA	MHC historic inventory site	16.2
Stonybrook HD (Indian Avenue HD)	Middletown	Newport	RI	NRHP-listed resource	16.2
St. Georges School	Middletown	Newport	RI	NRHP-listed resource	16.3
Hygeia House	New Shoreham	Washington	RI	NRHP-listed resource	16.3
US Weather Bureau Station	New Shoreham	Washington	RI	NRHP-listed resource	16.3
Miss Abby E. Vaill/ 1 of 2 Vaill cottages	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.4
Hon. Julius Deming Perkins/Bayberry Lodge	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.4
Lakeside Drive and Mitchell Lane	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.5
Land Trust Cottages	Middletown	Newport	RI	NRHP-eligible resource (RIHPHC determined)	16.6
Russell Hancock House	Chilmark	Dukes	MA	MHC historic inventory site	16.6
Westport Point HD (1)	Westport	Bristol	MA	NRHP-eligible resource (MHC determined)	16.7
Westport Point HD (2)	Westport	Bristol	MA	NRHP-listed resource	16.7
Mohegan Cottage / Everett Barlow House	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.7
Paradise Rocks HD	Middletown	Newport	RI	RIHPHC historic resource	16.8
Lewis-Dickens Farm	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	17.0
Island Cemetery/Old Burial Ground	New Shoreham	Washington	RI	RI Historical Cemetery	16.8
Kay St.-Catherine St.-Old Beach Road HD / The Hill	Newport	Newport	RI	NRHP-listed resource	16.9
Beacon Hill Road	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	16.9
Nathan Mott Park	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	17.1

Visually Sensitive Resource	Municipality	County	State	Resource Designation	Distance to nearest WTG (miles)
Champlin Farm	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	17.1
Block Island North Lighthouse	New Shoreham	Washington	RI	NRHP-listed resource	17.1
Hippocampus/Boy's camp/Beane Family	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	17.2
US Lifesaving Station	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	17.4
US Coast Guard Brick House	New Shoreham	Washington	RI	NRHP-eligible resource (RIHPHC determined)	17.4
Peleg Champlin House	New Shoreham	Washington	RI	NRHP-listed resource	17.5
Hancock, Captain Samuel - Mitchell, Captain West House	Chilmark	Dukes	MA	NRHP-eligible resource (MHC determined)	17.6
Scrubby Neck Schoolhouse	West Tisbury	Dukes	MA	MHC historic inventory site	18.0
Point Judith Lighthouse	Narragansett	Washington	RI	NRHP-listed resource	18.2
Bailey Farm	Middletown	Newport	RI	NRHP-listed resource	18.3
Beavertail Light	Jamestown	Newport	RI	NRHP-listed resource	18.4
Horsehead/Marbella	Jamestown	Newport	RI	NRHP-listed resource	18.6
Ocean Road HD	Narragansett	Washington	RI	NRHP-listed resource	18.9
Dunmere	Narragansett	Washington	RI	NRHP-listed resource	19.2
Puncatest Neck HD	Tiverton	Newport	RI	RIHPHC historic resource	19.4
Fort Varnum/Camp Varnum	Narragansett	Washington	RI	NRHP-eligible resource (RIHPHC determined)	19.6
Salters Point	Dartmouth	Bristol	MA	MHC historic inventory site	19.7
Dunes Club	Narragansett	Washington	RI	NRHP-listed resource	19.8
Life Saving Station at Narragansett Pier	Narragansett	Washington	RI	NRHP-listed resource	19.8
The Towers HD	Narragansett	Washington	RI	NRHP-listed resource	19.8
Narragansett Pier MRA	Narragansett	Washington	RI	NRHP-listed resource	19.8
The Towers / Tower Entrance of Narragansett Casino	Narragansett	Washington	RI	NRHP-listed resource	19.9

Visually Sensitive Resource	Municipality	County	State	Resource Designation	Distance to nearest WTG (miles)
Chappaquiddick Island TCP	Edgartown	Dukes	MA	NRHP-eligible resource (BOEM determined)	20
Brownings Beach HD	South Kingstown	Washington	RI	NRHP-listed resource	21.8
Tarpaulin Cove Light	Gosnold	Dukes	MA	NRHP-listed resource	22.1
Clark's Point Light	New Bedford	Bristol	MA	NRHP-listed resource	24.6
Fort Rodman	New Bedford	Bristol	MA	NRHP-eligible resource (MHC determined)	24.6
Fort Taber HD	New Bedford	Bristol	MA	NRHP-listed resource	24.6
744 Sconticut Neck Rd.	Fairhaven	Bristol	MA	MHC historic inventory site	25.9
Butler Flats Light Station	New Bedford	Bristol	MA	NRHP-listed resource	25.6
Nobska Point Lighthouse	Falmouth	Barnstable	MA	NRHP-listed resource	28.0

Source: EDR (2023a): Attachment A.
Note: HD = Historic District, MA = Massachusetts, RI = Rhode Island.

The identified viewshed resources susceptible to visual impacts tend to be those eligible for the NRHP under Criterion C for their distinctive characteristics of construction or composition or additionally under Criterion A for their important contributions to broad events in history. TCPs tend to further be eligible for the NRHP under Criterion B for their connection to important figures in tribal history and under Criterion D for their potential to contribute further information important to understanding tribal history. NHLs have elevated recognition for their exceptional significance at the national level representing an outstanding aspect of American history and culture. NHLs are further treated under the special requirements of NHPA Section 110(f) and 36 CFR 800.10 to minimize harm to them. NRHP-eligible viewshed resources identified as susceptible to visual impacts within the viewshed APE retain important historic settings that contribute to the resources' NRHP eligibility along with other aspects of integrity.

The Project and other ongoing and reasonably foreseeable activities would result in an adverse effect when it alters, directly or indirectly, any of the characteristics of a viewshed resource that qualify the resource for the NRHP in a manner that would diminish the integrity of the NRHP-eligible viewshed resource's location, design, setting, materials, workmanship, feeling, or association per 36 CFR 800.5(a)(1). Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5(a)(1)). NRHP-eligible aboveground cultural resources would be susceptible to adverse effects that diminish the integrity of the resource's significant historic features from the introduction of visual elements by the Project or other ongoing and reasonably foreseeable activities (36 CFR 800.5(a)(2)(v)). Larger-scale historic properties (e.g., expansive TCP landscapes and historic districts that contain multiple integral sites and features) are more likely to have views of Project elements and to have views of more Project structures and lighting than smaller individual historic properties, based on the results of the HRVEA (EDR 2023a); although, greater quantities of individual historic properties are located in the viewshed APE and, therefore, would be exposed to visual impacts in greater numbers. Impacts to any NRHP-eligible cultural resource, including viewshed resources, that are determined to be **moderate** or **major** as defined in this EIS, would rise to level of adverse effect per the criteria of adverse effect under NHPA Section 106. Impacts to cultural resources, that determined to be negligible or **minor** as **defined** in this EIS, would not rise to the level of adverse effects under the criteria of adverse effect under NHPA Section 106.

3.10.2 Environmental Consequences

3.10.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

Impacts on cultural resources—marine, terrestrial, and viewshed resources—are based on up to 100 WTGs and two OSSs, for a total of up to 102 foundations in the analysis area, the maximum-case scenario for foundation structures and connecting cables and infrastructure or facilities as considered in the PDE. Appendix D presents additional information on the PDE and maximum-case scenario.

If Revolution Wind instead installed fewer than 100 WTGs and WTGs larger in size than 8 MW, then potential variances in impacts would be anticipated. If 12-MW WTGs were to be installed, then the maximum height of the blade tip for WTGs would be 873 feet above the surface, compared to 696 feet for the 8-MW WTGs. Because the WTGs would exceed 699 feet, the FAA specifies additional mid-tower lighting, in addition to lighting at the top of the nacelle (FAA 2018). The taller WTGs and additional lighting would result in greater visual impacts within the viewshed APE, somewhat but not entirely offset by fewer WTGs being needed. The selection of a higher capacity turbine within the PDE (up to a 12-MW WTG) would proportionately reduce the number of WTGs and associated IAC in the Lease Area and increase the ability for the Project to avoid impacts to submerged marine cultural resources when compared to the 8-MW WTG option.

See Appendix E1 for a summary of IPFs analyzed for cultural resources across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have only a negligible potential for negative effects are excluded from Chapter 3 and provided in Appendix E1:Table E2-9. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component. Where feasible, calculations for specific alternative impacts are provided in Appendix E4, to facilitate reader comparison across alternatives.

Table 3.10-7 provides a summary of IPF findings carried forward for analysis in this section. Each alternative analysis discussion consists of the construction and installation phase, the O&M phase, the decommissioning phase, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion.

A detailed analysis of the Proposed Action is provided following the table. Detailed analysis of other considered action alternatives is also provided below the table if analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action.

The Conclusion section within each alternative analysis discussion includes rationale for the effects determinations.

The impact of any alternative would be **negligibl**e to **major** negative, depending on whether resources are unavoidable or discovered during Project activities or have unobscured views of Project structures. If previously undiscovered or unimpacted historic are identified and moderate to major negative effects cannot be avoided, BOEM would require that Revolution Wind implement the appropriate onshore or offshore post-review discovery plan (see Appendix J) to assess and resolve any negative effects pursuant to the MOA. NRHP-eligible cultural resources, if adversely affected, would be mitigated through the NHPA Section 106 process.

The impacts would be relatively uniform between the action alternatives, except Alternative E, where setbacks of WTGs from Martha's Vineyard, adjacent areas of mainland Rhode Island at Newport County (Aquidneck Island), and Block Island would provide advantages for avoiding and reducing **moderate** to **major** negative impacts to marine cultural resources and viewshed resources over the other action alternatives.

Table 3.10-7. Alternative Comparison Summary for Cultural Resources

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
Marine Cultural Resources							
Accidental releases and discharges	The accidental release of hazardous materials or debris and any associated cleanup that migrate from future offshore wind activities that are nearby could impact submerged marine cultural resources in the marine APE for the Project. Although not expected, a large-scale accidental release and associated cleanup could result in permanent, geographically extensive and temporary to long-term **minor** to **major** negative impacts on marine cultural resources.	**Offshore**: The Proposed Action could contribute accidental releases of fuel, fluids, or hazardous material; sediment; and/or trash and debris to conditions under the No Action Alternative. The risk would be increased primarily during construction but also would be present during operations and decommissioning. These releases, if any, would occur infrequently at discrete locations and vary widely in space and time, and for this reason, BOEM expects accidental releases and discharges would have localized temporary to short-term **negligible** impacts on marine cultural resources. The contribution from the Proposed Action would be a low percentage of the overall spill risk from ongoing and future activities. As a result, the Proposed Action when combined with past, present, and reasonably foreseeable activities would be expected to have temporary to short-term **negligible** to **minor** cumulative impacts to marine cultural resources.	**Offshore**: Impacts from accidental releases and discharges from Alternatives C through F on marine cultural resources would be similar to those described for the Proposed Action due to the similarity in Project activities and associated spill risks. Any spills from construction and O&M activities associated with Alternatives C through F would occur infrequently at discrete locations and vary widely in space and time. As a result, impacts from accidental releases and discharges are anticipated to be localized and temporary to short term **negligible**. Likewise, temporary to short-term **negligible** to **minor** cumulative impacts to marine cultural resources are anticipated.				**Offshore**: Similar to Alternatives C- through F, impacts from accidental releases and discharges from Alternative G on marine cultural resources during construction or O&M would be similar to those described for the Proposed Action and are anticipated to be localized and temporary to short term **negligible**. Likewise, temporary to short-term **negligible** to **minor** cumulative impacts to marine cultural resources are anticipated.
Anchoring	The development of future offshore wind activities could negatively affect marine cultural resources that connect to the current marine APE. Under the No Action Alternative, those marine cultural resources that the RWF has the potential to impact within its Lease Area and export cable corridor would be avoided and would result in no impacts by other reasonably foreseeable offshore wind activities.	**Offshore**: Vessel anchoring would be associated with seafloor disturbance activities (short and long term) proposed for the Project consisting of clearing/leveling of the seafloor, monopile foundation (and associated cable protection) construction, export cable installation, and OSS-link cable and IAC installation (preparation, trenching, burial, maintenance, replacement, etc.). Anchoring disturbance would affect up to 3,204 acres of the seafloor under the maximum-case scenario (see Table E4-1). The impacts to marine cultural resources would be irreversible and **major** negative unless all NRHP-eligible marine cultural resources and marine cultural resources significant to Native American tribes can be avoided during anchoring. The MARA identified 32 marine cultural resources within the RWF and RWEC, 19 of which are potential shipwrecks and 13 of which are ancient submerged landform features of significance to Native American tribes. Revolution Wind would	**Offshore**: Alternatives C through F would involve the same types or numbers of marine cultural resources at the RWF and RWEC offshore development areas as under the Proposed Action (see Figure 3.10-1). However, these alternatives could decrease the risk of disturbance and impacts to marine cultural resources because the number of constructed WTGs may be reduced and associated cable trenching may also decrease, resulting in greater Project flexibility for avoiding these resources. Therefore, vessel anchoring would result in less seafloor disturbance than is anticipated for the Proposed Action. The decreased number of WTGs anticipated for these alternatives would also reduce the length of IAC required and therefore reduce the acreage of seafloor disturbed by anchors during construction and installation. Potential anchorage disturbance is expected to reduce from the 3,203 acres under Alternative B to 2,066–2,098 acres under Alternative C, 2,510–2,985 acres under Alternative D, 2,066 or 2,605 acres under Alternative D, and as little as 1,812 acres under Alternative F (see Table E4-1). Compared to the Proposed Action, Alternative C would place WTG locations farther from seven of the 32 marine cultural resources, specifically 2.8 to 3.0 miles farther from ancient submerged landforms (Targets 28 and 27, respectively) and 0.25 mile to 2.5 miles farther from shipwrecks (Targets 2, 8, 17, 18, and 19, in order of increasing distance). Distances to other ancient submerged landforms and shipwrecks would not change under Alternative C. Alternative D could decrease the risk of disturbance and impacts to one potential shipwreck (Target 04) because the nearest WTG would be sited approximately 3.5 miles				**Offshore**: Similar to Alternatives C through F, Alternative G would involve the same types or numbers of marine cultural resources at the RWF and RWEC offshore development areas as under the Proposed Action (see Figure 3.10-1), and because the number of constructed WTGs and associated cables would be reduced, the acreage of seafloor disturbed by anchors during construction and installation would also be reduced. Potential anchorage disturbance is expected to reduce from the 3,204 acres under Alternative B to 2,098 acres under Alternative G (see Table E4-1). Compared to the Proposed Action, the 65 WTG turbine configuration of Alternatives G1, G2, and G3 would place WTG locations farther from nine of the 32 marine cultural resources, consisting of six potential shipwrecks (Targets 2, 3, 17, 18, 19, and 20), two shipwrecks (Targets 8 and 9), and one ancient submerged landform

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
		be expected under any BOEM approval of the COP to conduct O&M activities on equipment in areas that have been surveyed and found to contain no marine cultural resources and/or in areas that have previously experienced disturbance during construction. Therefore, impacts of anchoring on identified marine cultural resources, including shipwrecks and ancient submerged landforms, would be **negligible** during O&M activities. Decommissioning activities would be expected to take place in previously disturbed areas and therefore impacts to confirmed submerged cultural resources and identified ancient submerged landform features from anchoring would be **negligible** over the long term.	more distant from that shipwreck. Impacts would remain the same as the Proposed Action, however, if Alternative D retains WTG proximity to that shipwreck. As a result, Alternative D would not have the potential to reduce anchoring impacts to marine cultural resources as much as Alternative C (for progressive comparison to the other action alternatives, see Section 3.10.2.5). Alternative D would also maintain similar configurations to the Proposed Action at the other 28 marine cultural resources in the marine APE. Compared to the Proposed Action, the 64 WTG turbine configuration of Alternative E1 would place WTG locations farther from seven of the 32 marine cultural resources, consisting of two ancient submerged landforms (Targets 24 and 26), three known shipwrecks (Targets 01, 06, and 09), and two possible shipwrecks (Targets 07 and 16). Compared to the Proposed Action, the 81 WTG turbine configuration of Alternative E2 would place WTG locations farther from two marine cultural resources, consisting of one ancient submerged landform (Target 24) and one possible shipwreck site (Target 09). Either configuration of Alterative E would have more potential for anchoring impacts to marine cultural resources than Alternative C but less potential for anchoring impacts than either Alternative D or the Proposed Action. However, Alternative E increases the distance of Project WTGs to a different range of marine cultural resources than either Alternative C or Alternative D. Alternative E would result in similar impacts to the Proposed Action at the 22 to 27 marine cultural resources in the marine APE where its configurations do not provide farther avoidance distances. Vessel anchoring associated with Alternative F, which combines alternative WTG reduction options, would result in less seafloor disturbance than is anticipated for the Proposed Action or, potentially, the other action alternatives. Alternatives C through F would use the same RWEC as that of the Proposed Action. These alternatives would result in irreversible and **major** negative impacts to NRHP-eligible marine cultural resources if these resources could not be avoided during construction of the RWEC. Due to the similarity in Project activities and locations, the impacts of anchoring on identified marine cultural resources and ancient submerged landforms from O&M and decommissioning activities associated with Alternatives C through F would be similar to the Proposed Action. The impacts of anchoring or use of a jack-up barge on identified marine cultural resources, including shipwrecks and ancient submerged landforms, would be **negligible** during O&M, because O&M activities would be restricted to areas that have been surveyed and found to contain no marine cultural resources or that have previously experienced disturbance during construction. Decommissioning activities would be expected to take place in previously disturbed areas and therefore impacts to confirmed submerged cultural resources and identified ancient submerged landform features from anchoring would be long term **negligible** to **minor**. The reduced scale of Alternatives C through F would result in fewer potential impacts from seafloor disturbance activities than the Proposed Action. Anchoring from other future wind energy activities is not expected in the marine APE for the current Project; however, anchoring from other reasonably foreseeable non-wind activities in the marine APE could impact marine cultural resources. Should these impacts be added to by unavoidable impacts on marine cultural resources under Alternatives C through F, anchoring would result in irreversible and **negligible** to **major** negative cumulative impacts on marine cultural resources.				(Target 24). Alternative G1 could decrease the risk of disturbance and impacts to one ancient submerged landform (Target 27) because the maximum work area immediately adjacent to the target would be reduced by approximately 30 acres compared to the Proposed Action. WTG distances to other ancient submerged landforms and shipwrecks would not change under Alternative G1. Any of the Alternative G configurations would have less potential for anchoring impacts to marine cultural resources than the other alternatives or the Proposed Action. Alternative G would use the same RWEC as that of the Proposed Action. This alternative would result in irreversible and **major** negative impacts to NRHP-eligible marine cultural resources if these resources could not be avoided during construction of the RWEC. Due to the similarity in Project activities and locations, the impacts of anchoring on identified marine cultural resources and ancient submerged landforms from O&M and decommissioning activities associated with Alternative G would be similar to the Proposed Action. The impacts of anchoring or use of a jack-up barge on identified marine cultural resources, including shipwrecks and ancient submerged landforms, would be **negligible** during O&M because O&M activities would be restricted to areas that have been surveyed and found to contain no marine cultural resources or that have previously experienced disturbance during construction. Decommissioning activities would be expected to take place in previously disturbed areas and therefore impacts to confirmed submerged cultural resources and identified ancient submerged landform features from anchoring would be long term **negligible** to **minor**. The reduced scale of Alternative G would result in fewer potential impacts from seafloor disturbance activities than the Proposed Action. Anchoring from other future wind energy activities is not expected in the marine APE for the current Project; however, anchoring from other reasonably foreseeable non-wind

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							activities in the marine APE could impact marine cultural resources. Should these impacts be added to by unavoidable impacts on marine cultural resources under Alternative G, anchoring would result in irreversible and **negligible** to **major** negative cumulative impacts on marine cultural resources.
Climate change	The contribution of offshore wind energy projects on slowing or arresting global warming and climate change–related impacts could help reduce these climate change impacts and be beneficial to marine cultural resources. Although the degree to which future offshore wind activities would reduce the impacts of climate change trends on marine cultural resources in the marine APE is unknown, impacts from climate change trends are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on marine cultural resources would remain effectively permanent and therefore long term.	**Offshore**: The contribution of the Proposed Action on slowing or arresting global warming and climate change–related impacts could help reduce climate change impacts and be beneficial to marine cultural resources. The Proposed Action's contribution to effects from climate change trends on marine cultural resources would be **negligible** and impacts from climate change trends are anticipated to remain **minor** to **moderate** negative. Cumulative impacts from climate change trends are anticipated to remain **minor** to **moderate** negative even with the benefits of this Project since the ongoing effects of climate change on marine cultural resources would remain effectively permanent and therefore long term.	**Offshore**: Impacts from climate change trends on marine cultural resources from Alternatives C through F would be similar to those described for the Proposed Action. The overall magnitude of potential impacts resulting from climate change trends are uncertain but are anticipated to qualify as **minor** to **moderate** negative and long term. Renewable energy development by the Project under any action alternative and future offshore wind activities are anticipated to reduce the impacts of climate change trends to an unknown degree, but offshore wind development alone is anticipated to result in **negligible** contributions to impacts from climate change trends. Therefore, cumulative impacts from climate change trends are anticipated to remain **minor** to **moderate** negative.				**Offshore**: Similar to Alternatives C through F, impacts from climate change trends on marine cultural resources from Alternative G would be similar to those described for the Proposed Action: **minor** to **moderate** negative and long term. Renewable energy development by the Project under any action alternative and future offshore wind activities are anticipated to reduce the impacts of climate change trends to an unknown degree, but offshore wind development alone is anticipated to result in **negligible** contributions to impacts from climate change trends. Therefore, cumulative impacts from climate change trends are anticipated to remain **minor** to **moderate** negative.
New cable emplacement/ maintenance	Cable installation from future offshore wind activities and other submarine cables could physically impact marine cultural resources. However, no new cable emplacement or maintenance is anticipated within the current Project's marine APE from future offshore wind activities. Under the No Action Alternative, those marine cultural resources that the RWF has the potential to impact would be avoided and would result in no impacts by other reasonably foreseeable offshore wind activities.	**Offshore**: Installation of the IAC, OSS-link cable, and RWEC would impact the seafloor within the Lease Area and along the RWEC route. This includes potential MEC/UXOs removal in advance of seafloor preparation for RWEC installation. The construction and installation footprint for the RWEC would impact 1,390 acres of the seafloor (see Table E4-1). The operational footprint for the RWEC is calculated at 39.2 acres, and the cable would be emplaced to depths of up to 13 feet below the seafloor (see Table 2.1-8). The IAC and OSS-link cable would be emplaced at depths of up to 10 feet below the seafloor and require up to 2,619 acres of horizontal seafloor disturbance (see Table E4-1). Revolution Wind recommended a 50-m (164-foot) avoidance buffer on the 19 targets identified as shipwreck archaeological sites. Where Revolution Wind would avoid the shipwreck sites by a distance of 50 m (164 feet), the Project would have no impact on them. If these shipwreck and ancient submerged landforms are determined	**Offshore**: Cable emplacement for Alternatives C through F could impact marine cultural resources. The acreage of seafloor impacts associated with the RWEC under Alternatives C through E would be the same as the Proposed Action, but the acreage of the IAC emplaced would be reduced due to the reduction in WTGs installed under Alternatives C through F. As noted in the discussion of anchoring impacts above, Alternative C would place the WTGs and their connecting IAC farther from two ancient submerged landforms and five shipwrecks than the Proposed Action by placing WTGs 0.25 to 3.0 miles farther away. Where Alternative C is able to avoid more NRHP-eligible shipwreck sites and ancient submerged landforms than the Proposed Action through a reduction in and increased distances from cable emplacement, Alternative C would have less impacts on marine cultural resources than the Proposed Action. Alternative D would either avoid one or more shipwreck site(s) or, dependent on WTG configuration, have the same potential impacts on marine cultural resources as compared to the maximum-case scenario under the Proposed Action. In either case, Alternative D would not have the potential to reduce impacts from cable emplacement at marine cultural resources as much as Alternative C. Alternative E would place the WTGs and their connecting IAC farther from one to two ancient submerged landforms and one to five shipwreck sites than the Proposed Action by placing WTGs 0.8 to 4.4 miles farther away. Either analyzed configuration of Alterative E would have the potential to increase cable emplacement impacts to marine cultural resources compared to Alternative C and to reduce the potential for cable emplacement impacts in comparison to Alternative D and the Proposed Action; although, Alternative E				**Offshore**: Similar to Alternatives C through F, cable emplacement for Alternative G could impact marine cultural resources. The acreage of seafloor impacts associated with the RWEC under Alternative G would be the same as the Proposed Action, but the acreage of the IAC emplaced would be reduced to 2,010 acres (up to 23% less than the Proposed Action—see Table E4-1). This reduction is due to the reduction in WTGs installed under Alternative G. Alternative G would place the WTGs and their connecting IAC farther from two ancient submerged landforms and three to eight shipwreck sites than the Proposed Action by placing WTGs 1.9 to 3.7 miles farther away. However, the shift in WTG locations would result in a shift of IAC cabling, and the cabling shift would potentially increase impacts to one possible historic shipwreck (Target 10) and one ancient submerged landform (Target 28) by moving or increasing IAC cabling within these

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		eligible for the NRHP and they cannot be avoided by new cable emplacement, then the impacts would be irreversible and **major** negative. Although no new cables would be emplaced during O&M or decommissioning, Revolution Wind anticipates that it may be necessary to uncover or rebury portions of the IAC, OSS-link cable, and RWEC over the life of the Project. As a result, O&M and decommissioning activities related to cables are expected to result in long-term **negligible** to **minor** impacts to marine cultural resources. Cable installation from the Proposed Action, future offshore wind activities, and other submarine cable activities could impact marine cultural resources. Cable emplacement and maintenance from future offshore wind activities and other reasonably foreseeable activities are not expected in the marine APE at identified marine cultural resources and would not add cumulative impacts to the general impacts from Project cabling. Cumulative impacts from the Project in relation to other reasonably foreseeable offshore cabling activities would be **negligible** for the long term.	increases distance of Project WTGs to a different range of marine cultural resources than either Alternative C or Alternative D. The acreage of seafloor impacts associated with the installation of the RWEC and IAC under Alternative F would be somewhat less than the Proposed Action, but that cannot be quantified until the WTGs to be removed are identified. The acreage of the IAC emplaced would be reduced due to the reduction in WTGs installed under Alternative F. If Alternative F is able to avoid more NRHP-eligible shipwreck sites and ancient submerged landforms than the Proposed Action through a reduction in cable emplacement, then Alternative F could have less impacts on marine cultural resources than the Proposed Action. Where NRHP-eligible shipwreck sites and ancient submerged landforms remain unavoidable by Alternatives C through F, impacts from cable emplacement would be irreversible and long term **negligible** to **major** negative. Although no new cables would be emplaced during O&M or decommissioning activities for Alternatives C through F, Revolution Wind anticipates that it may be necessary to uncover or rebury portions of the RWEC over the life of the Project. As noted for the Proposed Action, it is expected that most, if not all, of the bottom disturbance associated with O&M and decommissioning would be located within previously disturbed areas. Avoidance or mitigation measures that were implemented for construction would be employed should activities extend outside previously disturbed areas (VHB 2023:552). For these reasons the potential impacts to marine cultural resources from cable maintenance under Alternatives C through F are similar to the Proposed Action for O&M and decommissioning and would be irreversible and long term **negligible** to **minor**. Cable emplacement under Alternatives C through F could impact marine cultural resources. The acreage of seafloor impacts associated with the RWEC under Alternatives C through F would be the same as the Proposed Action, but the acreage of IAC emplaced would be less due to the reduction in WTGs installed under Alternatives C through F. Where Alternatives C through F are able to avoid more NRHP-eligible shipwreck sites and ancient submerged landforms than the Proposed Action, Alternatives C through F would have less impacts on marine cultural resources than the Proposed Action. Where NRHP-eligible shipwreck sites and ancient submerged landforms remain unavoidable by Alternatives C through F, impacts from cable emplacement and maintenance would be irreversible and long term **negligible** to **major** negative. Similar to the Proposed Action, cable emplacement and maintenance from future wind energy activities and other reasonably foreseeable activities are not expected in the marine APE at identified marine cultural resources and would not add cumulative impacts to Alternatives C through F. Cumulative impacts from any action alternative for the Project in relation to other reasonably foreseeable offshore cabling activities would be **negligible** for the long term.				two targets (three IAC cables in parallel under Alternative G instead of one under the Proposed Action). Alternative G would also move IAC cabling 0.28 mile closer to one ancient submerged landform (Target 25). The three analyzed configurations of Alterative G would have the potential to increase cable emplacement impacts to marine cultural resources compared to Alternative C and Alternative E1 and to reduce the potential for cable emplacement impacts in comparison to Alternative D, Alternative E2, and the Proposed Action. Where NRHP-eligible shipwreck sites and ancient submerged landforms remain unavoidable by Alternative G, impacts from cable emplacement would be irreversible and long term **negligible** to **major** negative. Although no new cables would be emplaced during O&M or decommissioning activities for Alternative G, Revolution Wind anticipates that it may be necessary to uncover or rebury portions of the RWEC over the life of the Project. As noted for the Proposed Action, it is expected that most, if not all, of the bottom disturbance associated with O&M and decommissioning would be located within previously disturbed areas. Avoidance or mitigation measures that were implemented for construction would be employed should activities extend outside previously disturbed areas (VHB 2023:552). For these reasons, the potential impacts to marine cultural resources from cable maintenance under Alternative G are similar to the Proposed Action for O&M and decommissioning and would be irreversible and long term **negligible** to **minor**. Similar to Alternatives C- through F, cable emplacement under Alternative G could impact marine cultural resources. The acreage of seafloor impacts associated with the RWEC under Alternative G would be the same as the Proposed Action, but the acreage of IAC emplaced would be less due to the reduction in WTGs installed under Alternative G. Where Alternative G is able to avoid more NRHP-

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							eligible shipwreck sites and ancient submerged landforms than the Proposed Action, Alternative G would have less impacts on marine cultural resources than the Proposed Action. Where NRHP-eligible shipwreck sites and ancient submerged landforms remain unavoidable by Alternative G, impacts from cable emplacement and maintenance would be irreversible and long term **negligible** to **major** negative. Similar to the Proposed Action, cable emplacement and maintenance from future wind energy activities and other reasonably foreseeable activities are not expected in the marine APE at identified marine cultural resources and would not add cumulative impacts to Alternative G. Cumulative impacts from any action alternative for the Project in relation to other reasonably foreseeable offshore cabling activities would be **negligible** for the long term.
Presence of structures	Future offshore wind activities could impact marine cultural resources with the placement of in-water structures with foundations in the seafloor. However, no new structures are anticipated within the current Project's marine APE from future offshore wind activities or other reasonably foreseeable activities within the Project marine APE that do not require federal approval. Under the No Action Alternative, those marine cultural resources that the RWF has the potential to impact would be avoided and would result in no impacts by future offshore wind activities.	**Offshore**: Placement of the WTGs and OSSs would impact the seafloor within the Lease Area. The Project anticipates impacting up to 734.4 acres of seafloor for construction of the up to 100 WTG and up to two OSS locations (see Table E4-1). For shipwreck and ancient submerged landforms determined NRHP eligible and that can be avoided by the placement of WTGs and OSSs, the impacts would be long term **negligible**. Revolution Wind recommended a 50-m (164-foot) avoidance buffer for shipwrecks. If the shipwreck and ancient submerged landforms are determined NRHP eligible, and they cannot be avoided by construction of structures, then the impacts would be long term **major** negative. O&M and decommissioning activities at WTG and OSS structures would be located within previously disturbed areas or surveyed areas outside of identified marine cultural resources are expected to result in long-term **negligible** to **minor** impacts. Revolution Wind has determined it could avoid impacts to marine cultural resources within the Lease Area. Other future offshore wind energy activities would not place structures in the RWF Lease Area. Based on these factors, cumulative	**Offshore**: The elimination of WTGs under Alternatives C through F would reduce seafloor impacts over the Proposed Action. See anchoring and new cable emplacement/maintenance impacts, above, for analysis of the placement of WTGs (and the IACs that connect to them) relative to NRHP-eligible shipwreck sites and ancient submerged landforms. Potential construction disturbance for WTG and OSS locations is expected to reduce from the 734.4 acres under Alternative B to 475.2–482.4 acres under Alternative C, 576–84 acres under Alternative D, 475.2–597.6 acres under Alternative D, and as little as 417.6 acres under Alternative F (see Table E4-1). Where Alternatives C through F are able to avoid more NRHP-eligible shipwreck sites and ancient submerged landforms than the Proposed Action through a reduction in seafloor disturbance and increased distances from Project structures, these alternatives would have less impacts on marine cultural resources than the Proposed Action. Where NRHP-eligible shipwreck sites and ancient submerged landforms remain unavoidable by Alternatives C through F, impacts from Project structures would be irreversible and long term **negligible** to **major** negative. It is expected that O&M and decommissioning activities at the WTG and OSS structures under Alternatives C through F would be similar to the Proposed Action. As a result, the impacts to marine cultural resources from the presence of structures under Alternatives C through F would be similar to the Proposed Action and remain long term **negligible** to **minor**. Although Alternatives C through F would have reduced impacts to marine cultural resources over the Proposed Action, other future offshore wind energy activities would not place structures in the RWF Lease Area, and therefore the cumulative effects of Project structures on marine cultural resources would be the same under Alternatives C through E				**Offshore**: Similar to Alternatives C through F, the elimination of WTGs under Alternative G would reduce seafloor impacts over the Proposed Action. See anchoring and new cable emplacement/maintenance impacts, above, for analysis of the placement of WTGs (and the IACs that connect to them) relative to NRHP-eligible shipwreck sites and ancient submerged landforms. Potential construction disturbance for WTG and OSS locations is expected to reduce from the 734.4 acres under Alternative B to 482.4 acres under Alternative G (see Table E4-1). Where Alternative G is able to avoid more NRHP-eligible shipwreck sites and ancient submerged landforms than the Proposed Action through a reduction in seafloor disturbance and increased distances from Project structures, this alternative would have fewer impacts on marine cultural resources than the Proposed Action. Where NRHP-eligible shipwreck sites and ancient submerged landforms remain unavoidable by Alternative G, impacts from Project structures would be irreversible and long term **negligible** to **major** negative.

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		impacts from the Project in relation to other future offshore wind energy activities would be **negligible** for the long term.	as the Proposed Action. The cumulative impacts to marine cultural resources from the Project in relation to other future offshore wind energy activities would be **negligible** for the long term.				It is expected that O&M and decommissioning activities at the WTG and OSS structures under Alternative G would be similar to the Proposed Action. As a result, the impacts to marine cultural resources from the presence of structures under Alternative G would be similar to the Proposed Action and remain long term **negligible** to **minor**. Although Alternative G would have reduced impacts to marine cultural resources over the Proposed Action, other future offshore wind energy activities would not place structures in the RWF Lease Area and therefore the cumulative effects of Project structures on marine cultural resources would be the same under Alternative G as the Proposed Action. The cumulative impacts to marine cultural resources from the Project in relation to other future offshore wind energy activities would be **negligible** for the long term.
Terrestrial Cultural Resources							
Accidental releases and discharges	Construction of reasonably foreseeable onshore elements of future offshore wind activities could result in the accidental release of hazardous materials or debris; however, releases would generally be temporary to short term, localized, and in limited amounts (see Section 3.10.1). Such an accidental release could result in impacts to terrestrial cultural resources and TCPs associated with the cleanup of contaminated soils. No future offshore wind projects other than the RWF are known to have planned development activities or the potential for impacts on terrestrial cultural resources within the terrestrial APE. Beyond the Project's terrestrial APE, impacts to terrestrial cultural resources from other projects' construction-related activities would be short to long term and localized **negligible** to **minor** negative because of the low probability of an accidental release, the low volumes of material typically released in individual incidents, accepted practices	**Onshore**: Construction of onshore Project elements could result in the accidental release of hazardous materials or debris; however, releases would generally be temporary to short term, localized, and in limited amounts. Indirect physical impacts would be long term and **negligible** to **major** negative, depending on the nature and size of the accidental release, its spatial relationship to the cultural resource impacted, and the extent and intensity of cleanup activities required. Other indirect but primarily temporary to short-term impacts could include noise, vibration, and dust as well as visual impacts associated with cleanup activity related to accidental releases and discharges. These temporary to short-term impacts would be **negligible** to **minor** negative and minimized or avoided through application of state and local laws and regulations. The impacts from accidental releases and discharges resulting from Project O&M and decommissioning activities associated with the Proposed Action would be the same as those described for Project construction and installation. Indirect physical impacts would be	**Onshore**: Impacts from accidental releases and discharges from onshore Project activities or facilities on terrestrial cultural resources under Alternatives C through F, if any, would be the same as those described for the Proposed Action. Such impacts would be temporary to short term, localized, and in limited amounts to terrestrial cultural resources. Indirect physical impacts would be long term **negligible** to **major** negative and indirect temporary to short term. Impacts related to cleanup activities would be **negligible** to **minor** negative and minimized or avoided through the application of state and local laws and regulations. The impacts from accidental releases and discharges resulting from O&M and decommissioning activities associated with Alternatives C through F would be the same as those described for the Proposed Action and No Action Alternative. The overall magnitude of potential impacts resulting from accidental releases and discharges would be long term **negligible** to **major** negative, depending on the nature and size of the accidental release, its spatial relationship to the cultural resource impacted, and the extent and intensity of cleanup activities required. Similar to the Proposed Action, Alternatives C through F would contribute accidental releases of fuel, fluids, or hazardous material; sediment; and/or trash and debris to conditions present under the No Action Alternative. Within the terrestrial APE, no contribution is anticipated from other future offshore wind activities. Releases from other future development activities, if any, or ongoing use and maintenance of the historic Quonset Point Naval Air Station, would occur infrequently at discrete locations and vary widely in space and time, and for this reason, BOEM expects localized and temporary to short-term **negligible** cumulative impacts on terrestrial cultural resources at the Quonset Point Naval Air Station.				**Onshore**: Similar to Alternatives C through F, impacts from accidental releases and discharges from onshore Project activities or facilities on terrestrial cultural resources under Alternative G, if any, would be the same as those described for the Proposed Action. Such impacts would be temporary to short term, localized, and in limited amounts. Indirect physical impacts would be long term **negligible** to **major** negative and indirect temporary to short term. Impacts related to cleanup activities would be **negligible** to **minor** negative and minimized or avoided through the application of state and local laws and regulations. The impacts from accidental releases and discharges resulting from O&M and decommissioning activities associated with Alternative G would be the same as those described for the Proposed Action and No Action Alternative: long term **negligible** to **major** negative, depending on the nature and size of the accidental release, its spatial relationship to the cultural resource impacted,

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	used to prevent accidental releases, and the localized nature of such events.	long term **negligible** to **major** negative, depending on the nature and size of the accidental release, its spatial relationship to the cultural resource impacted, and the extent and intensity of cleanup activities required. The Proposed Action would contribute accidental releases of fuel, fluids, or hazardous material; sediment; and/or trash and debris to conditions present under the No Action Alternative. The risk of impact from accidental releases and discharges would be increased primarily during construction but also would be present during Project operations and decommissioning. Releases, if any, would occur infrequently at discrete locations and vary widely in space and time, and for this reason, BOEM expects localized temporary to short-term **negligible** negative cumulative impacts on terrestrial cultural resources within the terrestrial APE.					and the extent and intensity of cleanup activities required. Similar to the Proposed Action, Alternative G would contribute accidental releases of fuel, fluids, or hazardous material; sediment; and/or trash and debris to conditions present under the No Action Alternative. Within the terrestrial APE, no contribution is anticipated from other future offshore wind activities. Releases from other future development activities, if any, or ongoing use and maintenance of the historic Quonset Point Naval Air Station would occur infrequently at discrete locations and vary widely in space and time, and for this reason, BOEM expects localized and temporary to short-term **negligible** cumulative impacts on terrestrial cultural resources at the Quonset Point Naval Air Station.
Climate change	As noted for marine cultural resources, the degree to which future offshore wind activities would reduce the impacts of climate change on terrestrial cultural resources in the terrestrial APE is unknown. Impacts from climate change trends are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on terrestrial cultural resources would remain effectively permanent and therefore long term.	**Onshore**: The impacts of the Proposed Action would be the same as the No Action Alternative as relates to climate change. The contribution of the Project on slowing or arresting global warming and climate change–related impacts could help reduce these potential negative impacts and be beneficial to terrestrial cultural resources. Because of this, the Proposed Action's contribution to effects from climate change on these resources would be **negligible**. Although the degree to which future offshore wind activities would reduce the impacts of climate change on terrestrial cultural resources in the terrestrial APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Proposed Action since the ongoing effects of climate change on terrestrial cultural resources would remain effectively permanent and therefore long term. Cumulative impacts from climate change are anticipated to remain **minor** to **moderate** negative.	**Onshore**: Impacts from climate change on terrestrial cultural resources under Alternatives C through F would be similar to those described for the Proposed Action. The overall magnitude of potential impacts resulting from climate change are uncertain but are anticipated to qualify as **minor** to **moderate** negative and long term. Renewable energy development by the Project under any action alternative and future offshore wind activities are anticipated to reduce the impacts of climate change to an unknown degree, but offshore wind development alone is anticipated to result in long-term **negligible** contributions to impacts from climate change. Therefore, cumulative impacts from climate change are anticipated to remain **minor** to **moderate** negative.				**Onshore**: Similar to Alternatives C through F, impacts from climate change on terrestrial cultural resources under Alternative G would be similar to those described for the Proposed Action: **minor** to **moderate** negative and long term. Renewable energy development by the Project under any action alternative and future offshore wind activities are anticipated to reduce the impacts of climate change to an unknown degree, but offshore wind development alone is anticipated to result in long-term **negligible** contributions to impacts from climate change. Therefore, cumulative impacts from climate change are anticipated to remain **minor** to **moderate** negative.
Presence of structures	Reasonably foreseeable onshore activities could physically disturb archaeological sites in the terrestrial APE or surrounding areas, such as through new building construction. No historic buildings or	**Onshore**: The construction of onshore Project components would physically disturb two NRHP-eligible archaeological sites within the OnSS work area limits; one NRHP-ineligible archaeological site and one NRHP-ineligible isolated	**Onshore**: The onshore activities proposed under Alternatives C through F would be the same as those under the Proposed Action. Therefore, the potential for permanent **negligible** to **major** negative impacts to result from the presence of structures under Alternatives C through F on terrestrial cultural resources is anticipated.				**Onshore**: Similar to Alternatives C through F, the onshore activities proposed under Alternative G would be the same as those under the Proposed Action: the potential for permanent **negligible** to **major** negative

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	structures are located within the terrestrial APE; although the terrestrial APE intersects a portion of the historic Quonset Point Naval Air Station area. Future offshore wind activities will not result in onshore facility development in the terrestrial APE. As a result, within the Project's terrestrial APE, impacts to terrestrial cultural resources could be long term **negligible** negative.	archaeological artifact within the ICF work area limits; and the grounds of one aboveground historic property, the Quonset Point Naval Air Station area (Forrest and Waller 2023). Physical impacts to the historic Quonset Point Naval Air Station resources would be **negligible** to **minor** because no terrestrial cultural resources that contribute to the NRHP-eligibility of that aboveground historic property are anticipated in the terrestrial APE. Physical impacts would also be **negligible** to **minor** at the portions of the two archaeological sites within the OnSS work area limits where construction is able to avoid physical impacts and **moderate** to **major** negative in areas where construction is not able to avoid physical impacts to them. Overall, the potential is for permanent **negligible** to **major** negative impacts to result from the Project on terrestrial cultural resources. O&M and decommissioning activities would be expected to remain in areas of existing construction disturbance or areas of previous terrestrial cultural resources Phase 1 archaeological survey work. Physical impacts to these resources would be short to long term **negligible** negative where avoided by O&M and decommissioning activities and long term **minor** to **major** negative where ground-disturbing activities are not able to avoid these impacts. No future offshore wind projects other than the Project are expected to have development activities and impacts on terrestrial cultural resources within the terrestrial APE. The impacts from the presence of onshore structures under the Proposed Action would result in long-term **negligible** negative cumulative impacts within the terrestrial APE.	The impacts from the presence of structures on terrestrial cultural resources resulting from O&M and decommissioning activities associated with Alternatives C through F would be the same as those described for the Proposed Action. Overall, the potential is for permanent, **negligible** to **major** negative impacts. Project impacts would be **negligible** to **minor** where construction is able to avoid portions of the two NRHP-eligible archaeological sites and **moderate** to **major** negative where construction is not able to avoid these impacts. Similar to the Proposed Action, under Alternatives C through F, no future offshore wind projects other than the Project are expected to have development activities and impacts on terrestrial cultural resources within the terrestrial APE. The impacts from the presence of onshore structures under any action alternative would result in long-term **negligible** cumulative impacts within the terrestrial APE.				impacts to result from the presence of structures under Alternative G on terrestrial cultural resources is anticipated. The impacts from the presence of structures on terrestrial cultural resources resulting from O&M and decommissioning activities associated with Alternative G would be the same as those described for the Proposed Action. Overall, the potential is for permanent, **negligible** to **major** negative impacts. Project impacts would be **negligible** to **minor** where construction is able to avoid portions of the two NRHP-eligible archaeological sites and **moderate** to **major** negative where construction is not able to avoid these impacts. Similar to the Proposed Action, under Alternative G, no future offshore wind projects other than the Project are expected to have development activities and impacts on terrestrial cultural resources within the terrestrial APE. The impacts from the presence of onshore structures under any action alternative would result in long-term **negligible** cumulative impacts within the terrestrial APE.
New cable emplacement/ maintenance	New cable emplacement could affect terrestrial archaeological resources at onshore cable routes and at the landing site transitioning between onshore and offshore cabling from future offshore wind activities. Although the potential for permanent **minor** to **major** negative impacts on buried resources to result from other reasonably foreseeable	**Onshore**: The impacts from new cable emplacement and maintenance for the Proposed Action would not introduce greater impacts to terrestrial resources over the No Action Alternative in the terrestrial APE. The route selected for the onshore transmission cable is located within existing ROWs and would prioritize the avoidance and minimization of impacts to terrestrial cultural resources. The risk of	**Onshore**: The onshore activities proposed under Alternatives C through F would be the same as those under the Proposed Action. Therefore, impacts to terrestrial cultural resources from construction, O&M, and decommissioning of cable emplacement/maintenance would be long term **negligible** to **minor** as the risk of potentially encountering undisturbed archaeological deposits is minimal in these previously disturbed areas. Within the terrestrial APE, no impacts from new cable emplacement/maintenance under any future offshore wind activities are anticipated. The impacts from new cable				**Onshore**: Similar to Alternatives C through F, the onshore activities proposed under Alternative G would be the same as those under the Proposed Action. Therefore, impacts to terrestrial cultural resources from construction, O&M, and decommissioning of cable emplacement/maintenance would be long term **negligible** to **minor** as the risk of potentially encountering undisturbed archaeological

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	activities would remain (see Appendix E), no future offshore wind activities are being considered within the terrestrial APE of the Project. Therefore, no potential impacts are expected.	potentially encountering undisturbed archaeological deposits is minimized in these areas, and the resultant impact to terrestrial cultural resources would be long term **negligible** to **minor** negative. O&M and decommissioning activities associated with the Proposed Action for the onshore cable would be expected to remain in areas of existing construction disturbance or areas of previous terrestrial cultural resources Phase 1 archaeological survey work. Consequently, long-term **negligible** negative impacts would occur to terrestrial cultural resources during O&M and decommissioning activities. Within the Project's terrestrial APE, no future offshore wind projects other than the RWF are expected to have development activities and impacts on terrestrial archaeological resources. The impacts from new cable emplacement/maintenance under the Proposed Action would result in long-term **negligible** cumulative impacts.	emplacement/maintenance under any action alternative would result in long-term **negligible** cumulative impacts.				deposits is minimal in these previously disturbed areas. Within the terrestrial APE, no impacts from new cable emplacement/maintenance under any future offshore wind activities are anticipated. The impacts from new cable emplacement/maintenance under any action alternative would result in long-term **negligible** cumulative impacts.
Viewshed Resources							
Climate change	The effects of climate change on viewshed resources would be similar to those noted for marine and terrestrial cultural resources. Increased erosion along coastlines could lead to the collapse of coastal viewshed resources and elements of TCPs included among the viewshed resources. However, the contribution of offshore wind energy projects on slowing or arresting global warming and climate change–related impacts could help reduce these potential negative impacts and be beneficial to viewshed resources by hindering changes to the shoreline settings important to these resources. Although the degree to which future offshore wind activities would reduce the impacts of climate change trends on viewshed resources in the viewshed APE is unknown, impacts from climate change trends are anticipated to remain **minor** to **moderate** negative even with the benefits	**Offshore**: The impacts of the Proposed Action as they relate to climate change would be the same as the No Action Alternative. The Project's contribution to effects from climate change on these resources would be **negligible**. Although the degree to which future offshore wind activities would reduce the impacts of climate change on viewshed resources in the viewshed APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on viewshed resources would remain effectively permanent and therefore long term. Cumulative impacts of the Proposed Action as they relate to climate change would be the same as the No Action Alternative: **minor** to **moderate** and long term.	**Offshore**: Impacts of Alternatives C through F as they relate to climate change would be similar to the Proposed Action. The overall magnitude of potential impacts resulting from climate change are uncertain but are anticipated to qualify as **minor** to **moderate** negative and long term. Renewable energy development by the Project under any action alternative and future offshore wind activities are anticipated to reduce the impacts of climate change to an unknown degree, but offshore wind development alone is anticipated to result in **negligible** contributions to impacts from climate change. Therefore, cumulative impacts from climate change are anticipated to remain **minor** to **moderate** negative. Cumulative impacts of any action alternative as they relate to climate change would be the same as the No Action Alternative: **minor** to **moderate** and long term.				**Offshore**: Impacts of Alternative G as they relate to climate change would be similar to the Proposed Action. The overall magnitude of potential impacts resulting from climate change are uncertain but are anticipated to qualify as **minor** to **moderate** negative and long term. Renewable energy development by the Project under any action alternative and future offshore wind activities are anticipated to reduce the impacts of climate change to an unknown degree, but offshore wind development alone is anticipated to result in **negligible** contributions to impacts from climate change. Therefore, cumulative impacts from climate change are anticipated to remain **minor** to **moderate** negative. Cumulative impacts of any action alternative as they relate to climate change would be the same as the No Action Alternative: **minor** to **moderate** and long term.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
	of the Project since the ongoing effects of climate change on viewshed resources would remain effectively permanent and therefore long term.						
Light	Future offshore wind activities would impact viewshed resources in the long term from navigational and aviation lighting on structures and temporarily from construction lighting. Impacts from lighting would be most visible at night and from cultural resources that are along shorelines or on elevated locations with unobstructed views. A limited number of cultural resources would be affected and would include those for which the nighttime sky is a contributing element to historic integrity, such as resources on the nearest shores of Rhode Island and Massachusetts and their offshore islands. Construction lighting and decommissioning lighting associated with both onshore and offshore wind facilities would have temporary, intermittent, and localized impacts, whereas operations lighting would have longer term, continuous, and localized impacts, where not adequately obscured or diffused. Under the No Action Alternative, lighting from future offshore wind activities would have temporary to long-term **negligible** to **major** negative impacts on viewshed resources.	**Offshore**: Impacts from construction and installation lighting would be most visible at night and from cultural resources that are along shorelines or on elevated locations with unobstructed views. A limited number of the 451 NRHP-eligible viewshed resources identified in the HRVEA would be affected and would include those for which the nighttime sky is a contributing element to aspects of its integrity, such as resources on the nearest shores of Rhode Island and Massachusetts and their offshore islands. Of the 451 NRHP-eligible viewshed resources identified in the HRVEA, 350 would experience **negligible** to **minor** visual impacts, not rising to the level of adverse effects under the criteria of NHPA Section 106; seven of these are NHLs that would not experience harm in consideration of NHPA Section 110(f). Of the 451 NRHP-eligible viewshed resources, 101 are anticipated to experience **moderate** to **major** visual impacts (daytime or nighttime) from the WTGs or OSSs that would rise to the level of adverse effect under NHPA Section 106 (see Table 3.10-6). Of these 101 aboveground historic properties that would be negatively affected to a moderate to major extent that would rise to the level of adverse effect under the NHPA Section 106 criteria (36 CFR 800.5), five of these are NHLs, two are TCPs, and the remaining 91 are historic buildings, structures, and districts. Construction lighting and decommissioning lighting associated with both onshore and offshore wind facilities would have temporary, intermittent, and localized impacts, whereas operations lighting would have longer term, continuous, and localized impacts, where not adequately obscured or diffused. Aircraft detection lighting system use would substantially reduce the visual impact from Project lighting and make lighting visibility much more intermittent but would not eliminate the impact fully. Under the Proposed Action, lighting would have	**Offshore**: Compared to the maximum-case scenario under the Proposed Action, Alternatives C through F could decrease impacts to viewshed resources from construction and installation lighting for offshore wind structures because the number of constructed WTGs and their viewshed would be reduced. Lighting would be reduced from up to 100 WTGs under the Proposed Action to the following: • 64 or 65 WTGs (up to 35% to 36% less, respectively) under Alternative C. • 78 and 93 WTGs (up to 7% to 22% less) under Alternative D. These lighting impacts under Alternative D would remain greater than those of Alternative C. Alternative D3 would specifically remove the closest seven WTG locations to Block Island and have an increased advantage for reducing visual impacts on aboveground historic properties on the shores of that island over other action alternatives, except Alternative E2, which would remove even more WTGs on the Block Island side of the RWF, and Alternative G, which although differently configured, would have comparable WTG distances as Alternative D yet have fewer WTGs overall. • Between 64 and 81 WTGs (up to 36% to 19% less) under Alternative E. Alternative E1 configuration, in particular, would reduce the proximity of WTG lighting to Martha's Vineyard and toward mainland Rhode Island (see Figure 2.1-20). Alternative E2 would remove the closest WTGs to Martha's Vineyard and be most advantageous for reducing WTG proximity to Block Island; however, it would not be as effective overall as Alternative E1 for reducing WTG proximity to onshore areas. Although the distance of WTGs from Martha's Vineyard would increase under Alternative E specifically compared to other alternatives, the total number of lights and lighting impacts would remain greater than those of Alternative C and would reach the potential lower limit of light numbers and impacts of Alternative D. Alternative E is primarily focused on setbacks of WTGs from Martha's Vineyard and would effectively increase distances of Project lights to viewshed resources there, especially under Alternative E1 (see Figure 2.1-20). This especially includes increased setbacks from viewshed resources important to Native American tribes at Aquinnah, inclusive of the Edwin DeVries Vanderhoop Homestead, Gay Head Light, and Gay Head - Aquinnah Shops. Alternative E also further increases setbacks from Newport and Block Island (see Figure 2.1-21), including the Breakers, Marble House, and the Ocean Drive Historic District, Bellevue Avenue Historic District, and Southeast Lighthouse NHLs. The Alternative E setbacks for RWF WTGs would increase the distances to viewshed resources at Aquinnah by between approximately 0.25 and 1 mile, at Newport and mainland Rhode Island by approximately 4 miles, and at Block Island variably beginning at less than 1 mile and extending to over 4 miles. Therefore, Alternative E would be more effective in reducing visual impacts from the nearest potential WTGs to viewshed resources at Martha's Vineyard and along Rhode Island shores compared to other action alternatives but would not eliminate visual impacts to all viewshed resources and				**Offshore**: Compared to the maximum-case scenario under the Proposed Action, Alternative G could decrease impacts to viewshed resources from construction and installation lighting for offshore wind structures because the number of constructed WTGs and their viewshed would be reduced. Lighting would be reduced from up to 100 WTGs under the Proposed Action to 65 WTGs (35% less) under Alternative G. Alternative G would reduce the proximity of WTG lighting to Block Island and Martha's Vineyard and toward Newport and mainland Rhode Island (see Figure 2.1-22). Alternatives G1, G2, and G3 are similar to each other in terms of the reduction of WTG lighting to Martha's Vineyard and Block Island and toward Newport and mainland Rhode Island (see Figure 2.1-23, Figure 2.1-24, and Figure 2.1-25). Alternatives G1 and G2 would retain two WTGs closer to Martha's Vineyard, which Alternative G3 would remove, and Alternatives G1 and G3 would retain two WTGs closer to Block Island, which Alternative G2 would remove. See Appendix K, Figures K-15, K-16, and K-17. Alternatives G1, G2, and G3 would remove more of the closest WTGs to mainland Rhode Island, Newport, Martha's Vineyard, and Block Island when compared to the Proposed Action, Alternative C, and Alternatives D1 and D2. Alternatives G1, G2, and G3 would remove more of the closest WTGs to mainland Rhode Island, Newport, and Martha's Vineyard but would retain a comparable amount in proximity to Block Island, in comparison to Alternative D3. Alternatives G1, G2, and G3 would remove fewer of the closest WTGs to mainland Rhode Island, Newport, and Martha's Vineyard but would retain a comparable—yet differently configured—amount in proximity to Block Island, in comparison to Alternative E1. Alternatives G1, G2, and G3 would remove a

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		temporary to long-term **negligible** to **major** negative impacts on viewshed resources. Long-term **negligible** to **major** negative impacts would continue for viewshed resources during O&M. O&M would not add further to these impacts; however, removing WTGs and OSSs through decommissioning would provide a remedy to previous visual impacts created by lighting. The Proposed Action would add offshore lighting impacts from navigational and aviation hazard lighting systems on the WTGs and OSSs. The addition would include up to 100 WTGs with red aviation hazard flashing lights and up to 100 WTGs and two OSSs with marine navigation lighting, compared to the future offshore wind activities' potential of up to 955 WTGs and three OSS locations offshore of Rhode Island and Massachusetts (including RWF), as evaluated in a maximum-case scenario for the cumulative visibility analysis for the Project (EDR 2021b). Cumulatively, the Proposed Action when combined with past, present, and reasonably foreseeable activities could have intermittent and from temporary to long-term **negligible** to **major** negative impacts on viewshed resources.	would not result in fewer visible WTGs and offshore RWF lighting sources than Alternatives C or F. • As few as 56 WTGs (up to 44% less than the maximum of 100 WTG under the Proposed Action) under Alternative F when combined with any of the action alternatives (C1, C2, or E1) intended to allow for the fulfillment of the existing three PPAs' generation requirement of at least 704 MW. These lighting impacts under Alternative F could potentially be reduced from those of the other action alternatives, where WTG numbers are comparatively less. Although the level of impact would be reduced, the layout modification and construction activities proposed under Alternatives C through F would still include the same viewshed resources visually impacted under the Proposed Action and the same potential for impacts to these resources. Portions of all RWF WTGs would potentially be visible from approximately most of the 101 NRHP-eligible viewshed resources moderately to majorly impacted under the action alternatives. All action alternatives, regardless of planned WTG numbers, would have the WTG visibility reduced somewhat due to intervening land areas and with setback distance from the coastline. As described, those action alternatives with the fewest WTGs and the greatest distances of setback would have the least degree of potential visual impacts on viewshed resources. Under Alternatives C through F, the construction and installation of offshore Project components with lighting would have temporary to long-term **negligible** to **major** negative impacts to viewshed resources, similar to those of the Proposed Action. O&M and decommissioning of offshore Project components with lighting would have temporary to long-term **negligible** to **major** negative impacts to viewshed resources under Alternatives C through F, similar to those of the Proposed Action. Impacts from Project lighting would be removed upon completion of decommissioning. To the potential 955 WTGs modeled in a maximum-case scenario for other future offshore wind activities (EDR 2021b), Alternatives C through F would add offshore lighting impacts from navigational and aviation hazard lighting systems. The same 101 NRHP-eligible viewshed resources would continue to be negatively affected from a moderate to major degree by offshore lighting impacts in the viewshed APE under Alternatives C through F as the Proposed Action (per the criteria of adverse effects in 36 CFR 800). The cumulative offshore lighting impacts on viewshed resources in the viewshed APE associated with Alternatives C through F when combined with past, present, and reasonably foreseeable activities would be long term **negligible** to **major** negative, until decommissioning of the Project. However, for Alternative E, the visual proximity for impacts from offshore Project elements would specifically have increased setbacks from viewshed resources at Martha's Vineyard and the nearest shores of Rhode Island.				comparable but differently configured amount of the closest WTGs to mainland Rhode Island, Newport, Martha's Vineyard, and Block Island in comparison to the Alternative E2. Alternative G would also have a narrowed visible extent of WTG lights in a line across the horizon (within from 24 to 41 degree fields of view [EDR 2023c]), visible from NHLs at Block Island and Newport in proportion to the maximum number of proposed WTGs (65 total). From the Newport area, only Alternative D2 would have a narrower field of view of WTG lights (ranging from 35 to 37 degrees) across the horizon (EDR 2023c) but would have up to 92 WTGs, proportionately 42% more than Alternative G. Although the distances and configurations of WTGs from Block Island, Martha's Vineyard, and mainland areas would vary under Alternative G from the other alternatives, the total number of lights and lighting impacts under Alternative G would be greater than Alternative F, would remain similar to those of Alternative C and Alternative E1, but would be lower than the potential lower limit of light numbers and impacts of Action Alternatives B, D, and E2. As one of the action alternatives with the lowest number of proposed WTGs, where Alternative G increases distances to WTGs from sensitive viewshed resources at the nearest points of land—Block Island, Martha's Vineyard, Newport, and mainland Rhode Island, Alternative G would effectively reduce visual impacts (see Figure 2.1-22). This especially includes increased setbacks from viewshed resources important to Native American tribes at Aquinnah, inclusive of the Edwin DeVries Vanderhoop Homestead, Gay Head Light, and Gay Head - Aquinnah Shops. Alternative G also further increases setbacks from Newport and Block Island (see Figure 2.1-22), including the Breakers, Marble House, and the Ocean Drive Historic District, Bellevue Avenue Historic District, and Southeast Lighthouse NHLs. Compared to the Proposed Action, Alternative G setbacks for RWF WTGs would increase the distances to viewshed resources at Aquinnah by

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							a minimum of approximately 1.25 miles, at Newport and mainland Rhode Island by 1.15 mile, and up to 3.5 miles, depending on the WTG configuration used. In relation to Block Island, Alternative G would reduce the number of closest WTGs and remove the line of WTGs visible on the horizon from Block Island, removing the massing of RWF WTGs southeast and northeast of Block Island in comparison to the Proposed Action. Alternative G, in comparison to Alternative C, would continue to have WTGs in about the same proximity to Martha's Vineyard, although fewer of them under Alternative G, and the same changes as Alternative C in relation to Block Island, Newport, and mainland Rhode Island (in comparison to the Proposed Action). Alternative G, in comparison to Alternative D, would have increased setbacks from Martha's Vineyard, Newport, and mainland Rhode Island; however, in comparison to Alternative D3, Alternative G would have about the same increased setback distances from Block Island over the Proposed Action (with WTGs differently configured). Alternative G would not remove as many WTGs as far back from Martha's Vineyard as the nearest Alternative E1 WTG (which would be approximately 2 miles farther) or from Newport (which would be approximately 1.15 to 3.5 miles farther). Nor would Alternative G reduce WTG proximity as much from Block Island as Alternative E2 (where WTGs would begin at the same distance as Alternative G, but then recede further to the northwest, to distances of 1.15 to approximately 5.5 miles farther away). The distances by which Alternative F would increase WTG setbacks from shore in relation to the other action alternatives cannot be quantified until the additional WTGs to be removed are identified. With the combination of reduced WTG numbers and farther setbacks from shorelands, Alternative G would be more effective in reducing visual impacts from the nearest potential WTGs to viewshed resources at Martha's Vineyard, on Block Island, and along

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
							Rhode Island shores compared to other action alternatives, except Alternative E and potentially Alternative F (where Alternative F reduces WTG numbers by 14% lower than Alternative G). Nevertheless, Alternative G would not eliminate visual impacts to all viewshed resources and would not result in fewer visible WTGs and offshore RWF lighting sources than Alternatives C, E1, or F. Although the level of impact would be reduced, the layout modification and construction activities proposed under Alternative G would still include the same viewshed resources visually impacted under the Proposed Action and the same potential for impacts to these resources. Portions of all RWF WTGs would potentially be visible from approximately most of the 101 NRHP-eligible viewshed resources moderately to majorly impacted under the action alternatives. All action alternatives, regardless of planned WTG numbers, would have the WTG visibility reduced somewhat due to intervening land areas and with setback distance from coastlines. As described, those action alternatives with the fewest WTGs and the greatest distances of setback would have the least degree of potential visual impacts on viewshed resources. Under Alternative G, the construction and installation of offshore Project components with lighting would have temporary to long-term **negligible** to **major** negative impacts to viewshed resources, similar to those of the Proposed Action. O&M and decommissioning of offshore Project components with lighting would have temporary to long-term **negligible** to **major** negative impacts to viewshed resources under Alternative G, similar to those of the Proposed Action. Impacts from Project lighting would be removed upon completion of decommissioning.
		Onshore: Based on a field review of the viewshed analyses, the OnSS and ICF construction areas would be readily visible from two NRHP-eligible viewshed resources (EDR 2021a) within the viewshed APE. Temporary **negligible** negative impacts from lighting of onshore Project activities	**Onshore**: Temporary **negligible** impacts from lighting of onshore Project activities or facilities resulting from construction and installation of Alternatives C through F are expected on viewshed resources, similar to the Proposed Action. Impacts from lighting of onshore Project components during O&M and decommissioning would be the same for Project installation and construction under Alternatives C through F				**Onshore**: Temporary **negligible** impacts from lighting of onshore Project activities or facilities resulting from construction and installation of Alternative G are expected on viewshed resources, similar to the Proposed Action.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
		or facilities during construction and installation are expected on viewshed resources. The impacts from light resulting from O&M activities associated with the Proposed Action would be the same as those described for Project installation and construction: **negligible** but long-term. Long-term **negligible** impacts from lighting of onshore Project activities or facilities are expected on cultural resources in the viewshed APE, and these would not add cumulatively to the potential lighting impacts of other reasonably foreseeable activities.	as for the Proposed Action. Long-term **negligible** impacts to cultural resources from lighting of onshore Project activities or facilities would be expected in the viewshed APE. The same as the Proposed Action, light would result in no cumulative impacts to viewshed resources from Alternatives C through F.				Impacts from lighting of onshore Project components during O&M and decommissioning would be the same for Project installation and construction under Alternative G as for the Proposed Action. Long-term **negligible** impacts to cultural resources from lighting of onshore Project activities or facilities would be expected in the viewshed APE. The same as the Proposed Action, light would result in no cumulative impacts to viewshed resources from Alternative G.
Presence of structures	Within the viewshed APE, if BOEM selects the No Action Alternative, the development of future offshore wind projects' onshore infrastructure (the presence of structures) could introduce new visible elements to the setting of viewshed resources that would diminish their historic integrity, where there is an unimpeded line of sight from the viewshed resource to the onshore infrastructure. Within the offshore viewshed APE, the maximum-case scenario of 955 WTGs from all other future offshore wind activities would have a greater visual impact on most aboveground historic properties within the viewshed APE upon full build-out than would the RWF alone with its up to 100 WTGs. Under the No Action Alternative, the construction, installation, and O&M of future offshore wind activities could locate WTGs in the viewshed APE. Beginning at approximately 11 miles from NRHP-eligible viewshed resources at Nomans Land Island and extending to over 30 miles at NRHP-eligible viewshed resources at Long Island, New York, and mainland Connecticut, impacts from future offshore wind projects would result in long-term **negligible** to **major** negative visual impacts to NRHP-eligible viewshed resources in the viewshed APE, including NHLs.	**Offshore**: The construction of the offshore Project components would result in modifications to the existing setting of aboveground historic properties within the viewshed APE because a range of RWF WTG structures would be visible on the horizon from various viewshed resources on the shore during the daytime and structure lighting would be visible at night as addressed in the light impact discussion (EDR 2023a; see also Section 3.20 for further discussion). Visibility of WTG structures would have long term, intermittent, and localized impacts, where and when not adequately obscured or diffused. Of the 451 NRHP-eligible viewshed resources within the viewshed APE, 350 would have noncritical and/or limited views of WTGs. These 350 NRHP-eligible viewshed resources would experience **negligible** to **minor** visual impacts. The remaining 101 NRHP-eligible viewshed resources of the 451 are anticipated to experience **moderate** to **major** visual impacts (daytime or nighttime) from the WTGs or OSS. These 101 resources include five NHLs and two TCPs. Under the Proposed Action, the presence of offshore Project wind facilities would have long-term **negligible** to **major** negative impacts on viewshed resources for Project installation and construction through the life of the Project until decommissioning is complete. The Proposed Action would add up to 100 additional WTGs and up to two OSSs to the condition of the No Action Alternative within the viewshed APE. Visual impacts to viewshed resources from the Project would be long term	**Offshore**: Alternatives C through F could decrease impacts to viewshed resources when compared to the Proposed Action because the number of constructed WTGs and their viewshed would be reduced by up to 35% to 36% for Alternative C, 7% to 22% for Alternative D, 19% to 36% for Alternative E, and as much as 44% for Alternative F (when combined with Alternative C1, C2, or E1), as compared to the maximum-case scenario under the Proposed Action. Comparative analysis of Alternatives C through F and proportionality of visual impacts from the daytime visibility of offshore WTGs and OSSs on viewshed resources is the same as for nighttime lighting of these Project structures. Although the level of impact would be reduced, the layout modification and construction activities proposed under these alternatives would still include the same viewshed resources visually impacted under the Proposed Action and the same potential for impacts to these resources. Therefore, the construction and installation of offshore Project structures would have long-term **negligible** to **major** negative impacts to viewshed resources under Alternatives C through F, similar to those of the Proposed Action. The O&M and decommissioning of offshore Project components would have long-term **negligible** to **major** negative impacts to viewshed resources under Alternatives C through F, similar to but reduced from those of the Proposed Action. Impacts from the presence of structures offshore would be removed once decommissioning is complete. While the visual impacts from offshore Project structures described for construction and installation (see Section 3.10.2.4.1) would persist through O&M and decommissioning activities at 101 NRHP-eligible viewshed resources, including five NHLs and two TCPs, impacts would remain **negligible** to **minor** at the remaining 350 NRHP-eligible viewshed resources in the viewshed APE. To the potential 955 WTGs modeled in a maximum-case scenario for other future offshore wind activities (EDR 2021b), Alternatives C through F would add fewer WTGs than the Proposed Action. The same 101 NRHP-eligible viewshed resources continue to be negatively affected from a moderate to major degree by offshore presence of structures in the viewshed APE as the Proposed Action (per the criteria of adverse effects in 36 CFR 800). The cumulative visual impacts on viewshed resources in the viewshed APE associated with Alternatives C through F when combined with past, present, and reasonably foreseeable activities would be long term **negligible** to **major** negative, until decommissioning of the Project. However, for Alternative E, the visual proximity for				**Offshore**: Alternative G could decrease impacts to viewshed resources when compared to the Proposed Action, Alternative D, and Alternative E2 because the number of constructed WTGs and their viewshed would be reduced by 35% for Alternative G as compared to the maximum-case scenario under the Proposed Action and by at least 20% for the minimum case for these alternatives. The 35% reduction under Alternative G is comparable to the amount of reduction as would occur under Alternative C and Alternative E1, based on their WTG numbers; however, WTGs under Alternative G would be differently configured than under other alternatives, as discussed under Lighting, above. Alternative F would have 14% fewer WTGs than Alternative G, and the potential for an equivalent proportion of reduced visual impact on viewshed resources (although WTG setback distance changes cannot be quantified until the additional WTGs to be removed are identified under Alternative F). Comparative analysis of Alternative G and proportionality of visual impacts from the daytime visibility of offshore WTGs and OSSs on viewshed resources are the same as for nighttime lighting of these Project structures. Alternative G would also have a narrowed visible extent of WTGs in a line across the horizon (within fields of view from 24 to 41 degrees [EDR 2023c]), visible from NHLs at Block Island and Newport, in proportion to the maximum number of proposed WTGs (65 total).

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
		and **negligible** to **major** negative, minimized with distance and obstructions. The Proposed Action when combined with past, present, and reasonably foreseeable activities would result in long-term **negligible** to **major** negative cumulative negative impacts on NRHP-eligible viewshed resources, represented by aboveground historic properties, in the viewshed APE.	impacts from offshore Project elements would specifically have increased setbacks from viewshed resources at Martha's Vineyard and the nearest shores of Rhode Island.				From the Newport area, only Alternative D2 would have a narrower field of view of WTGs (ranging from 35 to 37 degrees) across the horizon (EDR 2023c) but would have up to 92 WTGs, proportionately 42% more than Alternative G. Although the level of impact would be reduced, the layout modification and construction activities proposed under Alternative G would still include the same viewshed resources visually impacted under the other action alternatives and the same potential for impacts to these resources. Therefore, the construction and installation of offshore Project structures would have long-term **negligible** to **major** negative impacts to viewshed resources under Alternative G, similar to those of the Proposed Action and other action alternatives. The O&M and decommissioning of offshore Project components would have long-term **negligible** to **major** negative impacts to viewshed resources under Alternative G, similar to, but reduced from, those of the Proposed Action, Alternative D, and Alternative E2, and about the same, but differently configured from, Alternatives C and E1. Impacts from the presence of structures offshore would be removed once decommissioning is complete. While the visual impacts from offshore Project structures described for construction and installation (see Section 3.10.2.4.1) would persist through O&M and decommissioning activities at 101 NRHP-eligible viewshed resources, including five NHLs and two TCPs, impacts would remain **negligible** to **minor** at the remaining 350 NRHP-eligible viewshed resources in the viewshed APE. To the potential 955 WTGs modeled in a maximum-case scenario for other future offshore wind activities (EDR 2021b), Alternative G would add more WTGs than Alternative F; fewer WTGs than the Proposed Action, Alternative D, and Alternative E2; and approximately the same number of WTGs as Alternative C and Alternative E1. Under Alternative G, the same 101 NRHP-eligible viewshed resources continue to be negatively

Impact-Producing Factor	**No Action Alternative**	**Alternative B (Proposed Action)** **Up to 100 WTGs**	**Alternative C** **(Habitat Alternative)** **64–65 WTGs**	**Alternative D** **(Transit Alternative)** **78–93 WTGs**	**Alternative E** **(Viewshed Alternative)** **64–81 WTGs**	**Alternative F** **(Higher Capacity Turbine Alternative)** **56 WTGs**	**Alternative G** **(Preferred Alternative)**
							affected from a moderate to major degree by the offshore presence of structures in the viewshed APE as the other action alternatives (per the criteria of adverse effects in 36 CFR 800). The cumulative visual impacts on viewshed resources in the viewshed APE associated with Alternative G when combined with past, present, and reasonably foreseeable activities would be long term **negligible** to **major** negative until decommissioning of the Project. However, for Alternative G, the visual proximity for impacts from offshore Project elements would specifically have increased setbacks from viewshed resources at Martha's Vineyard, on Block Island, and the nearest shores of Newport compared to the other action alternatives, except Alternative E.
		Onshore: For the onshore viewshed APE, construction and installation of the onshore Project facilities could introduce new visible elements to the setting of NRHP-eligible viewshed resources that would diminish their historic integrity, where there is an unimpeded line of sight between the resource and the onshore Project facilities. Although the NRHP-eligible Quonset Point Naval Air Station and Wickford Historic District are within the viewshed APE of the OnSS and ICF, these onshore Project facilities would be in scale and character with the current use of the Quonset Point Naval Air Station and would not introduce contrasting visual elements inconsistent with the existing setting of the Wickford Historic District. As a result of the construction and installation, O&M, and decommissioning of the onshore Project facilities, the potential visual impacts to the NRHP-eligible Quonset Point Naval Air Station and the Wickford Historic District would be long term **negligible** to **minor.** The Proposed Action's onshore facilities would not add cumulative impacts from the presence of structures resulting from other reasonably foreseeable activities.	**Onshore**: For the onshore viewshed APE, construction and installation of the onshore Project facilities under Alternatives C through F would be the same as those under the Proposed Action. Therefore, impacts to viewshed resources within the viewshed APE would be short to long term **negligible** to **minor** (the same as the Proposed Action). Impacts from the presence of structures resulting from O&M and decommissioning activities associated with onshore Project components would be the same for Project installation and construction under Alternatives C through F as for the Proposed Action. As a result of the O&M and decommissioning of the onshore Project facilities, the potential visual impacts to viewshed resources are anticipated to be **negligible** to **minor** for the long term. The same as the Proposed Action, the presence of onshore structures would result in no cumulative impacts from Alternatives C through F or the Proposed Action to viewshed resources.				**Onshore**: For the onshore viewshed APE, construction and installation of the onshore Project facilities under Alternative G would be the same as those under the Proposed Action. Therefore, impacts to viewshed resources within the viewshed APE would be short to long term **negligible** to **minor** (the same as the Proposed Action). Impacts from the presence of structures resulting from O&M and decommissioning activities associated with onshore Project components would be the same for Project installation and construction under Alternative G as for the Proposed Action. As a result of the O&M and decommissioning of the onshore Project facilities, the potential visual impacts to viewshed resources are anticipated to be **negligible** to **minor** for the long term. The same as the Proposed Action, the presence of onshore structures would result in no cumulative impacts from Alternative G or the Proposed Action to viewshed resources.

3.10.2.2 Alternative A: Impacts of the No Action Alternative on Marine Cultural Resources

3.10.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for marine cultural resources (see Section 3.10.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and permitted and constructed offshore wind COP projects within the cultural resources GAA. These IPFs are described and analyzed in Appendix E1.

3.10.2.2.2 Cumulative Impacts

This section discloses potential marine cultural resources impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

<u>Accidental releases and discharges</u>: The accidental release of hazardous materials or debris and any associated cleanup that migrate from future offshore wind activities that are nearby could impact submerged marine cultural resources in the marine APE for the Project. However, most releases would be temporary to short term and **negligible** negative and not measurably contribute to resource impacts because of the low probability of occurrence, low persistence time, and EPMs implemented to prevent releases. Although not expected, a large-scale accidental release and associated cleanup could result in permanent, geographically extensive and temporary to long-term **minor** to **major** negative impacts on marine cultural resources.

<u>Anchoring</u>: Development of future offshore wind activities is not expected within the Project's marine APE; however, the development of future offshore wind activities could negatively affect marine cultural resources that connect to the current marine APE. At the boundaries of the RWF Lease Area, the SFWF Lease Area does intersect ancient submerged landform features (Targets 27 and 28; see Table 3.10-3) and a shipwreck along the lease edge (Target 20; see Table 3.10-2). Deploying and repositioning anchors with associated wire rope, cable, and chain during construction and maintenance activities could impact the bottom surface and potentially disturb shipwrecks and ancient submerged landforms, resulting in the irreversible loss of cultural resources. The SFWF would avoid impacts to these lease-edge and other marine cultural resources within its lease area by design, but not all marine cultural resources are avoidable within the SFWF export cable corridor (BOEM 2021). Under the No Action Alternative, those marine cultural resources that the RWF has the potential to impact within its Lease Area and export cable corridor would be avoided and would result in no impacts by other reasonably foreseeable offshore wind activities. For other reasonably foreseeable activities within the Project marine APE that do not require its federal approval, BOEM would have no ability to add historic preservation requirements, and impacts to marine cultural resources could go unmitigated as a result of activities that are not federally reviewed.

<u>Climate change</u>: Factors related to climate change, including sea level rise, increased storm severity/frequency, increased sedimentation and erosion, and ocean acidification, could also result in long-term and permanent impacts on marine cultural resources. Ancient submerged landforms and associated cultural resources on the OCS have already experienced the effects of climate change because they were inundated when the last ice age ended (BOEM 2012:3-423). This includes being exposed to erosion during and after inundation. Climate change could introduce new erosive factors at ancient

submerged landforms and shipwrecks. Federal studies on the negative effects of climate change on shallow water shipwrecks point to accelerated decomposition (National Ocean Service 2021). Conversely, the contribution of offshore wind energy projects on slowing or arresting global warming and climate change–related impacts could help reduce these climate change impacts and be beneficial to marine cultural resources. Because of this, the Project's contribution to effects from climate change on these resources would be **negligible** negative. Although the degree to which future offshore wind activities would reduce the impacts of climate change on marine cultural resources in the marine APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on marine cultural resources would remain effectively permanent and therefore long term.

New cable emplacement/maintenance: Cable installation from future offshore wind activities and other submarine cables could physically impact marine cultural resources. This includes removal of potential MEC/UXOs in advance of seafloor preparation for RWEC installation. In addition to general horizontal acreage of seafloor disturbance, the extent of potential impacts to marine cultural resources increases with depth of disturbance into the seafloor, and cable emplacement and maintenance could reach depths able to impact more shallowly buried ancient submerged landforms, if present, as well as shallowly sediment-covered shipwrecks. The RI-MA WEA contains numerous shipwrecks, related debris fields, and ancient submerged landform features, which future offshore construction activities could impact, as indicated by the MARA and previous wind farm studies in the vicinity (Gray & Pape 2019, 2020; SEARCH 2023). See Figure 1.1-2 for New England WEAs. However, no new cable emplacement or maintenance is anticipated within the current Project's marine APE from future offshore wind activities. Under the No Action Alternative, those marine cultural resources that the RWF has the potential to impact would be avoided and would result in no impacts by other reasonably foreseeable offshore wind activities. For other reasonably foreseeable activities within the Project's marine APE that do not require its federal approval, BOEM would have no ability to add historic preservation requirements. Any sunken military craft and debris fields would continue to be protected under Public Law 108–375 Title XIV. Impacts to other marine cultural resources could go unmitigated as a result of activities that are not federally reviewed.

Presence of structures: Future offshore wind activities could impact marine cultural resources with the placement of in-water structures with foundations in the seafloor. In addition to general horizontal acreage of seafloor disturbance, the extent of potential impacts to marine cultural resources increases with depth of disturbance into the seafloor and WTG and OSS foundations would typically reach depths able to penetrate ancient submerged landforms if present, as well as sediment-covered shipwrecks. The RI-MA WEA contains numerous shipwrecks, related debris fields, and ancient submerged landform features, which future offshore construction activities could impact as indicated by the MARA and previous wind farm studies in the vicinity (Gray & Pape 2019, 2020; SEARCH 2023). However, no new structures are anticipated within the current Project's marine APE from future offshore wind activities or other reasonably foreseeable activities within the Project marine APE that do not require federal approval. Under the No Action Alternative, those marine cultural resources that the RWF has the potential to impact would be avoided and would result in no impacts by future offshore wind activities.

3.10.2.2.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on marine cultural resources associated with the Project would not occur. No new structures, cable emplacement, or maintenance activities are anticipated within the Project's marine APE from future offshore wind activities.

Under the No Action Alternative, BOEM anticipates those marine cultural resources that the RWF has the potential to impact would be avoided and would result in no impacts by future offshore wind activities. Marine cultural resources in the marine APE consist of ancient submerged landforms and shipwrecks. Although the effects of climate change would continue on these marine cultural resources in the marine APE, the degree to which the future offshore wind activities analyzed would reduce these impacts is unknown. However, the contribution of offshore wind energy activities, including the Project, to the impacts of climate change would be **negligible**, but the overall impacts of climate change on marine cultural resources would effectively be permanent.

Considering all the IPFs together, BOEM anticipates that no impacts would result from future offshore wind activities in the marine APE. For other reasonably foreseeable activities within the Project marine APE that do not require its federal approval, BOEM would have no ability to add historic preservation requirements, and impacts to marine cultural resources could go unmitigated as a result of activities that are not federally reviewed and therefore could be long term **negligible** to **major** negative.

3.10.2.3 Alternative A: Impacts of the No Action Alternative on Terrestrial Cultural Resources

3.10.2.3.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for terrestrial cultural resources (see Section 3.10.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the cultural resources GAA. These IPFs are described and analyzed in Appendix E1.

3.10.2.3.2 Cumulative Impacts

This section discloses potential terrestrial cultures resources impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

<u>Accidental releases and discharges:</u> Construction of reasonably foreseeable onshore elements of future offshore wind activities could result in the accidental release of hazardous materials or debris; however, releases would generally be temporary to short term, localized, and in limited amounts (see Section 3.10.1). Such an accidental release could result in impacts to terrestrial cultural resources and TCPs associated with the cleanup of contaminated soils. Indirect physical impacts would be long term and **negligible** to **major** negative, depending on the nature and size of the accidental release, its spatial relationship to the cultural resource impacted, and the extent and intensity of cleanup activities required. Archaeological resources and TCPs are more likely to experience indirect physical impacts through damage to or destruction of cultural materials or tribally sensitive resources during the removal of contaminated soils than are aboveground standing structures. Other indirect but primarily temporary to short-term impacts could include noise, vibration, and dust as well as visual impacts associated with cleanup activity related to accidental releases and discharges. These temporary to short-term impacts

would be **negligible** to **minor** and minimized or avoided through application of state and local laws and regulations regarding air quality (see Section 3.4.1). No future offshore wind projects other than the RWF are known to have planned development activities or the potential for impacts on terrestrial cultural resources within the terrestrial APE. Beyond the Project's terrestrial APE, impacts to terrestrial cultural resources from other projects' construction-related activities would be short to long term and localized **negligible** to **minor** negative because of the low probability of an accidental release, the low volumes of material typically released in individual incidents, accepted practices used to prevent accidental releases, and the localized nature of such events.

Climate change: As noted for marine cultural resources, climate change is anticipated to also result in long-term **minor** to **moderate** negative permanent impacts on terrestrial cultural resources. Sea level rise could lead to the inundation of terrestrial cultural resources, and increased storm severity and frequency would be expected to increase the severity and frequency of damage to coastal terrestrial cultural resources. Ocean acidification could impact traditional uses of coastal TCPs. However, the contribution of offshore wind energy projects on slowing or arresting global warming and climate change–related impacts could help reduce these potential negative impacts and be beneficial to terrestrial cultural resources. Because of this, the Project's contribution to effects from climate change on these resources would be long term and **negligible**. Although the degree to which future offshore wind activities would reduce the impacts of climate change on terrestrial cultural resources in the terrestrial APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on terrestrial cultural resources would remain effectively permanent and therefore long term.

Presence of structures: Reasonably foreseeable onshore activities could physically disturb archaeological sites in the terrestrial APE or surrounding areas, such as through new building construction. No historic buildings or structures are located within the terrestrial APE. Future offshore wind activities will not result in onshore facility development in the terrestrial APE. As a result, within the Project's terrestrial APE, impacts to terrestrial cultural resources could be long term **negligible** negative. For other reasonably foreseeable activities within the Project terrestrial APE that do not require federal approval, BOEM would have no ability to add historic preservation requirements, and impacts to terrestrial cultural resources could go unmitigated as a result of activities that are not federally reviewed.

New cable emplacement/maintenance: New cable emplacement could affect terrestrial archaeological resources at onshore cable routes and at the landing site transitioning between onshore and offshore cabling from future offshore wind activities. Although BOEM would be able to add terrestrial cultural resources identification requirements and mitigation measures for future offshore wind projects, the potential for permanent **minor** to **major** negative impacts on buried resources to result from other reasonably foreseeable activities would remain. However, because no future offshore wind activities are being considered within the terrestrial APE of the Project, no potential impacts are expected.

3.10.2.3.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on terrestrial cultural resources associated with the Project would not occur. Examples of individual terrestrial cultural resources are terrestrial archaeological sites and TCPs. Impacts could vary widely because the impacts are dependent on the unique characteristics of the individual resources. However, future offshore wind activities are not known to have impacts occurring in the terrestrial APE of the proposed Project. As described in Appendix E1, BOEM anticipates that the range of impacts for ongoing activities and reasonably foreseeable activities other than offshore wind would be long term **negligible** to **major** negative, where impacts to terrestrial cultural resources could go unmitigated as a result of activities that are not federally reviewed.

Considering all the IPFs together, BOEM anticipates that long-term **negligible** to **major** negative impacts would result only from other ongoing activities, reasonably foreseeable activities other than offshore wind, and reasonably foreseeable environmental trends and not from other future offshore wind activities since none are planned in the terrestrial APE. Where not avoidable, these impacts would be **negligible** to **major** negative on terrestrial cultural resources because they would be irreversible and long term. The NRHP-eligible Mill Creek Swamp #1 and #2 archaeological sites could be subject to future development, potentially without federal historic preservation requirements, even if the proposed Project were not to occur.

3.10.2.4 Alternative A: Impacts of the No Action Alternative on Viewshed Resources

3.10.2.4.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for viewshed resources (see Section 3.10.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the cultural resources GAA. These IPFs are described and analyzed in Appendix E1.

3.10.2.4.2 Cumulative Impacts

This section discloses potential viewshed resources impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

<u>Climate change:</u> The effects of climate change on viewshed resources would be similar to those noted for marine and terrestrial cultural resources. Increased erosion along coastlines could lead to the collapse of coastal viewshed resources and elements of TCPs included among the viewshed resources. However, the contribution of offshore wind energy projects on slowing or arresting global warming and climate change–related impacts could help reduce these potential negative impacts and be beneficial to viewshed resources by hindering changes to the shoreline settings important to these resources. Because of this, the Project's contribution to effects from climate change on these resources would be long term **negligible** negative. Although the degree to which future offshore wind activities would reduce the impacts of climate change on viewshed resources in the viewshed APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on viewshed resources would remain effectively permanent and therefore long term.

<u>Light</u>: Future offshore wind activities would impact viewshed resources in the long term from navigational and aviation lighting on structures and temporarily from construction lighting. Impacts from lighting would be most visible at night and from cultural resources that are along shorelines or on elevated locations with unobstructed views. A limited number of cultural resources would be affected and

would include those for which the nighttime sky is a contributing element to historic integrity, such as resources on the shores of Rhode Island and Massachusetts and their offshore islands. Future offshore wind activities could locate WTGs a minimum of 11.3 miles from Nomans Land Island, 15.0 miles from Martha's Vineyard, 16.8 miles from Nantucket Island, 16.9 miles from Block Island, 23.1 miles from mainland Rhode Island at Point Judith, 24.5 miles from Newport, and 30.5 miles from Long Island. The distances between the areas with viewshed resources and the nearest offshore wind lighting sources would reduce the intensity but not eliminate negative lighting impacts at all viewshed resources. The intensity of lighting impacts would also be reduced by the number, luminosity, and proximity of existing light sources near the resources (building and streetlights, onshore vehicle and offshore vessel lights). The intensity of lighting impacts would further be limited by atmospheric and environmental conditions (clouds, fog, and waves) that could partially or completely obscure or diffuse sources of light from offshore and onshore wind Project components. Construction lighting and decommissioning lighting associated with both onshore and offshore wind facilities would have temporary, intermittent, and localized impacts, whereas operations lighting would have longer term, continuous, and localized impacts, where not adequately obscured or diffused. Under the No Action Alternative, lighting from future offshore wind activities would have temporary to long-term **negligible** to **major** negative impacts on viewshed resources.

Presence of structures: For the onshore viewshed APE, if BOEM selects the No Action Alternative, the development of future offshore wind projects' onshore infrastructure (the presence of structures) could introduce new visible elements to the setting of viewshed resources that would compromise their historic integrity, where there is an unimpeded line of sight from the viewshed resource to the onshore infrastructure. Within the offshore viewshed APE, a maximum-case scenario of 955 WTGs from all other future offshore wind activities (as modeled specific to viewshed resources [EDR 2021b])[33] would have a greater visual impact on most locations within the viewshed APE upon full build-out than would the RWF alone with its up to 100 WTGs. Far more of the 451 NRHP-eligible viewshed resources (including 12 NHLs) identified in the viewshed APE would be negatively affected from a moderate to major degree by future offshore wind projects collectively than the 101 NRHP-eligible viewshed resources (including five NHLs) anticipated to be adversely affected (as defined under the NHPA Section 106 regulations at 36 CFR 800.5). Cumulative effects from the additive visual effects that would occur across future offshore wind projects. Under the No Action Alternative, the construction, installation, and O&M of future offshore wind activities could locate WTGs in the viewshed APE. Beginning at approximately 11 miles from NRHP-eligible viewshed resources at Nomans Land Island and extending to over 30 miles at NRHP-eligible viewshed resources at Long Island, New York, and mainland Connecticut, impacts from future offshore wind projects would result in long-term **negligible** to **major** negative visual impacts to NRHP-eligible viewshed resources in the viewshed APE. These impacts would be temporary from construction vessels and long term from O&M vessels, and minimized with distance and intervening factors such as atmospheric haze, angle of view of the viewshed resource, and other screening elements in the environment, such as trees and buildings or structures. Decommissioning would remove the visual impacts of the Project.

[33] Please note that the modelling for the cumulative development of future offshore wind activities for viewshed resources (EDR 2021b), which is based on the maximum-case scenario of 955 WTGs (or 1,055 when RWF WTGs are included under the Proposed Action), carries over from and is retained for consistency with the CHRVEA (SWCA 2023); therefore, the number differs from the 876 WTG total for the OCS (without the Proposed Action) that is presented for other resources in Table E4-1.

3.10.2.4.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on viewshed resources associated with the Project would not occur. However, ongoing and future activities would continue to have short to long-term **negligible** to **major** negative impacts on viewshed resources, primarily through the presence of structures and lighting that would be readily visible from these resources during the day and at night.

BOEM anticipates that the range of impacts for future offshore wind activities would be long term **negligible** to **major** negative, depending on the scale and extent of impacts and the unique characteristics of the viewshed resource. Examples of individual viewshed resources are historic aboveground structures and TCPs. Impacts vary widely because the impacts are dependent on the unique characteristics of the individual resources. As described in Appendix E1, BOEM anticipates that the range of impacts for ongoing activities and reasonably foreseeable activities other than offshore wind would be long-term **negligible** to **major** negative, for similar reasons.

Considering all the IPFs together, BOEM anticipates that long-term **negligible** to **major** negative impacts would result from future offshore wind activities in the viewshed APE when combined with ongoing activities and reasonably foreseeable activities other than offshore wind. This is because, where not avoidable, the overall impact on viewshed resources would be long term and potentially permanent.

3.10.2.5 Alternative B: Impacts of the Proposed Action on Marine Cultural Resources

3.10.2.5.1 Construction and Installation

Offshore Activities and Facilities

Accidental releases and discharges: The Proposed Action could contribute accidental releases of fuel, fluids, or hazardous material; sediment; and/or trash and debris to conditions under the No Action Alternative. The risk would be increased primarily during construction but also would be present during O&M and decommissioning. All vessels would comply with USCG requirements for the prevention and control of oil and fuel spills. Proper vessel regulations and operating procedures would minimize impacts resulting from the release of debris, fuel, hazardous material, or waste on marine cultural resources (BOEM 2012). Additionally, required training and awareness of BMPs proposed for waste management and mitigation of marine debris for RWF Project personnel would reduce the likelihood of occurrence to a very low risk. These releases, if any, would occur infrequently at discrete locations and vary widely in space and time, and for this reason, BOEM expects accidental releases and discharges would have localized temporary to short-term **negligible** negative impacts on marine cultural resources.

Anchoring: Vessel anchoring would be associated with seafloor disturbance activities (short and long term) proposed for the Project consisting of clearing/leveling of the seafloor, monopile foundation (and associated cable protection) construction, export cable installation, and OSS-link cable and IAC installation (preparation, trenching, burial, maintenance, replacement, etc.). Anchoring disturbance would affect up to 3,178 acres of the seafloor under the maximum-case scenario (see Table E4-1). Revolution Wind has committed to prioritizing and giving preference to the avoidance and minimization of impacts to potential submerged archaeological sites and ancient submerged landforms in siting the RWF and RWEC (VHB 2023). A plan for construction-related vessels would be developed prior to construction to identify no-anchorage areas to avoid documented sensitive resources. Additionally, a post-review discovery plan (in Appendix J) would be implemented that would include stop-work and notification procedures to be followed if a potentially significant cultural resource is encountered during construction. The impacts to many of the identified potential submerged historic-period cultural resources and some of the potential ancient submerged landforms may be avoided or minimized through redesign. However, some of the potential ancient submerged landforms are large and may not be avoidable by the RWEC during construction. Revolution Wind recommended 50-m (164-foot) avoidance buffers on the 19 targets identified as possible shipwreck archaeological sites. The impacts to marine cultural resources would be irreversible and **major** negative unless all NRHP-eligible marine cultural resources and marine cultural resources significant to Native American tribes can be avoided during anchoring.

Climate change: The impacts of the Proposed Action as they relate to climate change would be the same as the No Action Alternative and would be **negligible**. Refer to Section 3.10.1.1 for the No Action Alternative discussion. Although the degree to which future offshore wind activities would reduce the impacts of climate change on marine cultural resources in the marine APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Proposed Action since the ongoing effects of climate change on marine cultural resources would remain effectively permanent and therefore long term.

New cable emplacement/maintenance: Cable emplacement for the Proposed Action could physically impact marine cultural resources. Installation of the IAC, OSS-link cable, and RWEC would impact the seafloor within the Lease Area and along the cable route. These impacts result from preparation of the seafloor for installation of new cables by sandwave leveling and clearance of debris, boulders, and other objects as well as from the cable lay and burial. This could include removal of potential MEC/UXOs in advance of seafloor preparation for RWEC installation. The construction and installation footprint for the RWEC would impact 1,390 acres of the seafloor (see Table E4-1). The operational footprint for the RWEC is calculated at 39.2 acres, and the cable would be emplaced to depths of up to 13 feet below the seafloor (see Table 2.1-8). The IAC and OSS-link cable would be emplaced at depths of up to 10 feet below the seafloor and require up to 2,619 acres of horizontal seafloor disturbance. Revolution Wind recommended a 50-m (164-foot) avoidance buffer on the 19 targets identified as shipwreck archaeological sites (see Table E4-1). Three of the 19 shipwreck archaeological sites (Targets 11, 13, and 14) and eight of the 13 ancient submerged landforms (Targets 21, 22, 23, 29, 30, 31, 32, and 33) are located along the RWEC. Seven of the shipwreck archaeological sites (Targets 06, 07, 08, 09, 10, 16, and 19) and three ancient submerged landforms (Targets 26, 27, and 28) are located in planned IAC corridors within the RWF. Where Revolution Wind would avoid the shipwreck sites by a distance of 50 m (164 feet), the Project would have no impact on them. Although a large portion of each of the three ancient submerged landforms is located below the maximum vertical extent for the installation of the IACs, portions of all three may be impacted. As discussed in Anchoring above, impacts to some of the shipwreck archaeological sites and ancient submerged landforms may be avoided by adjustments to cable route and by using a DP vessel instead of an anchored vessel for the cable lay. If these shipwreck and ancient submerged landforms are determined eligible for the NRHP and they cannot be avoided by new cable emplacement, then the impacts would be irreversible and **major** negative.

Presence of structures: Placement of the WTGs and OSSs would impact the seafloor within the Lease Area. Revolution Wind selected monopile foundations as the WTG for the Proposed Action (VHB 2023). The limits of the Proposed Action were defined as the 200-m (656-foot) radius temporary workspace limit surrounding each WTG. The Project anticipates impacting up to 734.4 acres of seafloor for construction of the up to 100 WTG and up to two OSS locations (see Table E4-1). Revolution Wind recommended a 50-m (164-foot) avoidance buffer on targets identified as shipwreck archaeological sites. One shipwreck archaeological site (Target 05) and two ancient submerged landforms (Targets 25 and 28) are located within 200 m of a WTG foundation location. Two of ancient submerged landforms (Targets 27 and 28) would be avoidable through Project micrositing (SEARCH 2023). For shipwreck and ancient submerged landforms determined NRHP eligible and that can be avoided by the placement of WTGs and OSSs, the impacts would be long term **negligible** negative. If these shipwreck and ancient submerged landforms are determined NRHP eligible, and they cannot be avoided by construction of structures, then the impacts would be long term **major** negative.

3.10.2.5.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Accidental releases and discharges: Accidental releases of fuel, fluids, or hazardous material; sediment; and/or trash and debris to conditions could occur during O&M and decommissioning. The contribution of releases during these activities would be the same as during construction (refer to section 3.10.2.2.1), and for this reason, BOEM expects localized and temporary **negligible** negative impacts on marine cultural resources from accidental releases and discharges.

Anchoring: Revolution Wind would be expected under any BOEM approval of the COP to conduct O&M activities on equipment in areas that have been surveyed and found to contain no marine cultural resources and/or in areas that have previously experienced disturbance during construction. Because of this, during O&M, Revolution Wind would avoid the no-anchorage areas identified to avoid documented sensitive resources. Therefore, impacts of anchoring or use of a jack-up barge on identified marine cultural resources, including shipwrecks and ancient submerged landforms, would be **negligible** during O&M activities. Decommissioning activities would be expected to take place in previously disturbed areas and therefore impacts to confirmed submerged cultural resources and identified ancient submerged landform features from anchoring would be **negligible** over the long term.

Climate change: The impacts of the Proposed Action as they relate to climate change would be the same as the No Action Alternative and would be **negligible**. Refer to Section 3.10.1.1 for the No Action Alternative discussion. Although the degree to which future offshore wind activities would reduce the impacts of climate change on marine cultural resources in the marine APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on marine cultural resources would remain effectively permanent and therefore long term.

New cable emplacement/maintenance: Although no new cables would be emplaced during O&M or decommissioning, Revolution Wind anticipates that it may be necessary to uncover or rebury portions of the IAC, OSS-link cable, and RWEC over the life of the Project. It is expected that most, if not all, of the bottom disturbance would be located within previously disturbed areas or surveyed areas outside identified marine cultural resources. However, should it be necessary for maintenance activities to extend outside previously disturbed areas, avoidance or mitigation measures implemented for construction would be employed (VHB 2023). As a result, O&M and decommissioning activities related to cables are expected to result in long-term **negligible** to **minor** negative impacts to marine cultural resources.

Presence of structures: It is expected that O&M and decommissioning activities at WTG and OSS structures would be located within previously disturbed areas or surveyed areas outside of identified marine cultural resources. As a result, O&M and decommissioning activities related to WTGs and OSSs are expected to result in long-term **negligible** to **minor** negative impacts to marine cultural resources.

3.10.2.5.3 Cumulative Impacts

Offshore Activities and Facilities

Accidental releases and discharges: The Proposed Action could contribute accidental releases of fuel, fluids, or hazardous material; sediment; and/or trash and debris to conditions present under the No Action Alternative. The risk would be increased primarily during construction but also would be present during O&M and decommissioning. Refer to Section 3.10.2.2.1 for a discussion of the risk for spills and the measures put in place to avoid, minimize, and mitigate them. These accidental releases, if any, would occur infrequently at discrete locations and vary widely in space and time, and for this reason, BOEM expects localized and temporary to short-term **negligible** negative impacts from accidental releases and discharges on marine cultural resources. As a result, the Proposed Action when combined with past, present, and reasonably foreseeable activities would be expected to have temporary to short-term **negligible** to **minor** negative cumulative impacts to marine cultural resources.

Anchoring: Seafloor disturbance from anchoring would occur during construction of the RWF and RWEC. Revolution Wind has committed to prioritizing and giving preference to the avoidance and minimization of impacts to potential submerged archaeological sites and ancient submerged landforms in siting the RWF and RWEC (VHB 2023) and to implementing an anchoring plan and a post-review discovery plan. As noted for the No Action Alternative, impacts from a combination of reasonably foreseeable offshore projects to submerged cultural resources, or the larger submerged landforms within which these submerged cultural resources are identified, would result in cumulative impacts to these resources. Within its EPMs, Revolution Wind would prioritize avoidance; however, avoidance may not be feasible for all marine cultural resources identified along the export cable corridor. Although anchoring from other future wind energy activities is not expected, anchoring from other reasonably foreseeable activities in the marine APE could impact marine cultural resources. Should these impacts be added to by unavoidable impacts of the Proposed Action on marine cultural resources along its export cable corridor, anchoring would result in irreversible and **negligible** to **major** negative cumulative impacts on marine cultural resources.

Climate change: Cumulative impacts of the Proposed Action as they relate to climate change would be the same as the No Action Alternative and would be **negligible**. Refer to Section 3.10.1.1 for the No Action Alternative discussion. Although the degree to which future offshore wind activities would reduce the impacts of climate change on marine cultural resources in the marine APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of this Project since the ongoing effects of climate change on marine cultural resources would remain effectively permanent and therefore long term.

New cable emplacement/maintenance: Cable installation from the Proposed Action, future offshore wind activities, and other submarine cable activities could impact marine cultural resources. Installation of the IAC, OSS-link cable, and RWEC would impact the seafloor within the Lease Area and along the RWEC route. These impacts result from preparation of the seafloor for installation of new cables by sandwave leveling and clearance of debris, boulders, and other objects as well as from the cable lay and burial. The Project and other future offshore wind activities are expected to implement plans to avoid and minimize impacts on submerged marine cultural resources. Since shipwrecks are typically limited in extent, it is often possible to avoid impacting them during cable installation and maintenance. Ancient submerged landforms are generally larger and may extend substantially beyond the maximum work area or Lease Area for an undertaking; for this reason, it is not always feasible to avoid these features through redesign of a project. Although Revolution Wind has determined it could avoid impacts to marine cultural resources within the Lease Area, it is likely that all construction disturbances associated with the Project would not be avoidable at NRHP-eligible marine cultural resources within the export cable route. Cable emplacement and maintenance from future offshore wind activities and other reasonably foreseeable activities are not expected in the marine APE at identified marine cultural resources and would not add cumulative impacts to the general impacts from Project cabling. Cumulative impacts from the Project in relation to other reasonably foreseeable offshore cabling activities would be **negligible** negative for the long term.

Presence of structures: WTG and OSS placement by the Proposed Action and future offshore wind activities could impact marine cultural resources as described in Section 3.10.2.2.1 above. The Project and other future offshore wind activities are expected to implement plans to avoid and minimize impacts on submerged marine cultural resources during construction, O&M, and decommissioning. Revolution Wind has determined it could avoid impacts to marine cultural resources within the Lease Area. Other future offshore wind energy activities would not place structures in the RWF Lease Area. Based on these factors, cumulative impacts from the Project in relation to other future offshore wind energy activities would be **negligible** negative for the long term.

3.10.2.5.4 Conclusions

Under the Proposed Action, the construction and installation of offshore components, as well as their O&M, would have long-term **major** negative impacts on marine cultural resources that are not avoidable by seafloor-disturbing activities from the Project. **Major** negative impacts would be limited to those unavoidable impacts that result in a substantial loss of qualifying characteristics of a marine cultural resource for NRHP inclusion. **Major** negative impacts from the Proposed Action would result from the physical disturbance or damage of all or part of an NRHP-eligible marine cultural resource. Although these impacts would be constrainable to the portions of ancient submerged landform features that Revolution Wind is unable to avoid during RWEC installation, the final magnitude of these impacts would be long term **minor** to **moderate** negative. Measures determined by BOEM and stipulated within the ROD to avoid, minimize, and/or mitigate negative effects on NRHP-eligible marine cultural resources would reduce the level of impact. The exception is where impacts would render the resource ineligible for the NRHP even with mitigation, in which case the impact on the marine cultural resource would remain **major**. Also, impacts to previously undiscovered marine cultural resources identified during implementation of the Proposed Action could be long term **minor** to **major** negative. However, BOEM would require that Revolution Wind implement the offshore post-review discovery plan pursuant to the MOA (see Appendix J), which includes provisions for stop-work and notification procedures to be followed if a marine cultural resource is encountered during construction and installation, O&M, and decommissioning. This plan would serve to reduce the level of impact to previously undiscovered, NRHP-eligible marine cultural resources to long term **moderate** negative or lower (**minor** or **negligible**).

In the context of other reasonably foreseeable environmental trends and planned actions, the impacts under the Proposed Action resulting from individual IPFs would range from long term **negligible** to **major** negative. Considering all the IPFs together, BOEM anticipates that the overall impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in long-term **negligible** to **major** negative impacts to marine cultural resources. BOEM made this determination because, while overall moderate to major negative effects to NRHP-eligible marine cultural resources would be mitigated in accordance with NHPA Section 106 regulations, irreversible and long-term impacts would remain.

3.10.2.6 Alternative B: Impacts of the Proposed Action on Terrestrial Cultural Resources

3.10.2.6.1 Construction and Installation

Onshore Activities and Facilities

<u>Accidental releases and discharges:</u> As discussed in the No Action Alternative (see Section 3.10.1.2), construction of onshore Project elements could result in the accidental release of hazardous materials or debris; however, releases would generally be temporary to short term, localized, and in limited amounts. Indirect physical impacts would be long term and **negligible** to **major** negative, depending on the nature and size of the accidental release, its spatial relationship to the cultural resource impacted, and the extent and intensity of cleanup activities required. Other indirect but primarily temporary to short-term impacts could include noise, vibration, and dust as well as visual impacts associated with cleanup activity related to accidental releases and discharges. These temporary to short-term impacts would be **negligible** to **minor** negative and minimized or avoided through application of state and local laws and regulations.

<u>Climate change:</u> The impacts of the Proposed Action would be the same as the No Action Alternative as relates to climate change and would be **negligible**. Refer to Section 3.10.1.2 for the No Action Alternative discussion. Although the degree to which future offshore wind activities would reduce the impacts of climate change on terrestrial cultural resources in the terrestrial APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Proposed Action since the ongoing effects of climate change on terrestrial cultural resources would remain effectively permanent and therefore long term.

<u>Presence of structures:</u> The construction of onshore Project components would physically disturb the two archaeological sites within the OnSS work area limits and the one archaeological site and one isolated archaeological artifact within the ICF work area limits (Forrest and Waller 2023). The Mill Creek Swamp #1 and Mill Creek Swamp #2 archaeological sites within the OnSS work area limits are eligible for the NRHP, and physical impacts to these resources would be **negligible** to **minor** in site portions that construction is able to avoid and **moderate** to **major** negative in site portions where construction is not able to avoid physical impacts. The Quonset Substation archaeological site and the QDC Find Spot artifact within the ICF work area limits are recommended not eligible for the NRHP, and any physical impact to them would result in **negligible** to **minor** negative impacts.

Overall, the potential is for permanent **negligible** to **major** negative impacts to result from the Project on terrestrial cultural resources. Where the NRHP-eligible Mill Creek Swamp #1 and Mill Creek Swamp #2 archaeological sites cannot be avoided by OnSS development, BOEM would require further archaeological mitigation at these resources, in compliance with NHPA Section 106. BOEM would require that Revolution Wind implement the onshore post-review discovery plan (see Appendix J) during ground-disturbing activities at any of the four terrestrial cultural resources should any further archaeological resources be discovered during construction, O&M, or decommissioning.

New cable emplacement/maintenance: The impacts from new cable emplacement and maintenance for the Proposed Action would not introduce greater impacts to terrestrial resources over the No Action Alternative in the terrestrial APE (see Section 3.10.1.2.1). The cable landing envelope use and the crossing of the historic Quonset Point Naval Air Station would produce **negligible** negative long-term impacts. The route selected for the onshore transmission cable is located within existing ROWs and would minimize impacts to, or avoid, potential terrestrial cultural resources. Additionally, the onshore transmission cable route has been substantially altered by development, demolition, remediation, and associated grading activities postdating 1941. Also, BOEM would require that Revolution Wind implement the onshore post-review discovery plan pursuant to the MOA (see Appendix J), which includes provisions for stop-work and notification procedures to be followed if a terrestrial cultural resource is encountered during cable emplacement or maintenance. This plan would serve to reduce the level of impact to previously undiscovered, NRHP-eligible terrestrial cultural resources to long term **moderate** negative or lower (**minor** or **negligible**). Therefore, the risk of potentially encountering undisturbed archaeological deposits is minimized in these areas, and the resultant impact to terrestrial cultural resources would be long term **negligible** to **minor** negative.

3.10.2.6.2 Operations and Maintenance and Decommissioning

Onshore Activities and Facilities

Accidental releases and discharges: The impacts from accidental releases and discharges resulting from Project O&M and decommissioning activities associated with the Proposed Action would be the same as those described for Project construction and installation (see Section 3.10.2.3.1). As a result, indirect physical impacts would be long term **negligible** to **major** negative, depending on the nature and size of the accidental release, its spatial relationship to the cultural resource impacted, and the extent and intensity of cleanup activities required.

Climate change: The impacts of the Proposed Action would be the same as the No Action Alternative as it relates to climate change and would be long-term **negligible**, and impacts from climate change are anticipated to remain long term **minor** to **moderate** negative.

Presence of structures: O&M and decommissioning activities would remain in areas of existing construction disturbance, areas mitigated for archaeology prior to construction, and areas of previous terrestrial cultural resources Phase 1 survey work found not to contain NRHP-eligible archaeology sites. Therefore, these activities would proceed outside of, and avoid, unmitigated areas of NRHP-eligible archaeological sites Mill Creek Swamp #1 and #2. Should unmitigated areas of Mill Creek Swamp #1 and #2 archaeological sites not be avoidable by O&M or decommissioning at the OnSS, then BOEM would require further archaeological mitigation at these resources, in compliance with NHPA Section 106. BOEM would require that Revolution Wind implement that the post-review discovery plan prepared for Project construction (see Appendix J) during ground-disturbing O&M or decommissioning to address any additional buried archaeological deposits unexpectedly encountered during these activities.

Physical impacts to these resources would be short to long term **negligible** negative when avoided by O&M and decommissioning activities and long term **minor** to **major** negative if ground-disturbing activities are not able to avoid these impacts.

New cable emplacement/maintenance: The impacts from new cable emplacement/maintenance resulting from O&M and decommissioning activities associated with the Proposed Action would not introduce greater impacts to terrestrial resources over the No Action Alternative in the terrestrial APE. Maintenance of the cable within the historic Quonset Point Naval Air Station would produce impacts that are long term and **negligible**. O&M and decommissioning activities for the onshore cable would be expected to remain in areas of existing construction disturbance or areas of previous terrestrial cultural resources Phase 1 survey work. Consequently, long-term **negligible** negative impacts would occur to terrestrial cultural resources during O&M and decommissioning activities.

3.10.2.6.3 Cumulative Impacts

Onshore Activities and Facilities

Accidental releases and discharges: The Proposed Action would contribute accidental releases of fuel, fluids, or hazardous material; sediment; and/or trash and debris to conditions present under the No Action Alternative. The Proposed Action would have development activities potentially occurring at the historic Quonset Point Naval Air Station. The risk of impact from accidental releases and discharges would be increased primarily during construction but also would be present during Project operations and decommissioning. Compliance with federal, state, and local requirements for the prevention and control of accidental releases and discharges would minimize impacts on terrestrial cultural resources (BOEM 2012). Releases, if any, would occur infrequently at discrete locations and vary widely in space and time, and for this reason, BOEM expects localized temporary to short-term **negligible** negative cumulative impacts on terrestrial cultural resources within the terrestrial APE.

Climate change: Cumulative impacts of the Proposed Action would be the same as the No Action Alternative as it relates to climate change and would be **negligible**. Refer to Section 3.10.1.1 for the No Action Alternative discussion. Although the degree to which future offshore wind activities would reduce the impacts of climate change on terrestrial cultural resources in the terrestrial APE is unknown, cumulative impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on terrestrial cultural resources would remain effectively permanent and therefore long term.

Presence of structures: No future offshore wind projects other than the Project are expected to have development activities and impacts on terrestrial cultural resources within the terrestrial APE. The impacts from the presence of structures under the Proposed Action could result in long-term **negligible** negative cumulative impacts within the terrestrial APE. The Proposed Action is anticipated to result in impacts to the Mill Creek Swamp #1 and #2 archaeological sites; no cumulative effects from the onshore components of reasonably foreseeable offshore wind activities are anticipated at these two terrestrial cultural resources.

New cable emplacement/maintenance: Within the Project's terrestrial APE, no future offshore wind projects other than the RWF are expected to have development activities and impacts on terrestrial archaeological resources. The impacts from new cable emplacement/maintenance under the Proposed

Action could result in long-term **negligible** cumulative impacts at the historic Quonset Point Naval Air Station where combined with other non-offshore wind project development or ongoing use or maintenance at that site.

3.10.2.6.4 Conclusions

Under the Proposed Action, the construction and installation of onshore components, as well as their O&M and decommissioning, would have long-term **negligible** to **major** negative impacts on terrestrial cultural resources within the terrestrial APE. **Negligible** impacts would occur where NRHP-eligible terrestrial cultural resources could be avoided and would be temporary to short term. **Minor** impacts would occur and be temporary to short term (for the period of Project activity) where Project impacts might take place on an NRHP-eligible terrestrial cultural resource, such as the Quonset Point Naval Air Station, but not alter any qualifying characteristics that make the resource eligible for NRHP inclusion. **Moderate** to **major** negative long-term impacts would be limited to unavoidable impacts that would result in the loss of qualifying characteristics of a terrestrial cultural resource for NRHP inclusion. **Moderate** to **major** negative impacts from the Proposed Action would result from the physical disturbance or damage of all or part of a NRHP-eligible terrestrial cultural resource and be long term and irreversible. Also, impacts to previously undiscovered, NRHP-eligible terrestrial cultural resources identified during implementation of the Proposed Action could be irreversible and long-term **major** negative. However, BOEM would require that Revolution Wind implement the onshore post-review discovery plan pursuant to the MOA (see Appendix J), which includes provisions for stop-work and notification procedures to be followed if a cultural resource is encountered during construction and installation, O&M, and decommissioning. This plan would serve to reduce the level of impact to previously undiscovered, NRHP-eligible terrestrial cultural resources to **moderate** negative or lower levels of impact; however, impacts would remain long term and irreversible.

In the context of other reasonably foreseeable environmental trends and planned actions, the impacts under the Proposed Action resulting from individual IPFs would range from **negligible** to **major** negative. Considering all the IPFs together, BOEM anticipates that the overall impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in **negligible** to **major** negative impacts to terrestrial cultural resources within the terrestrial APE. BOEM made this determination because, while overall moderate to major negative effects to NRHP-eligible terrestrial cultural resources would be mitigated in accordance with NHPA Section 106 regulations, irreversible and long-term impacts would remain. In comparison, the No Action Alternative is expected to result in long-term **negligible** to **major** negative effects to terrestrial cultural resources in the terrestrial APE, depending on whether cultural resources can be avoided.

3.10.2.7 Alternative B: Impacts of the Proposed Action on Viewshed Resources

3.10.2.7.1 Construction and Installation

Offshore Activities and Facilities

Climate change: The impacts of the Proposed Action as they relate to climate change would be the same as the No Action Alternative and would be **negligible**. Refer to Section 3.10.1.3 for the No Action Alternative discussion. Although the degree to which future offshore wind activities would reduce the impacts of climate change on viewshed resources in the viewshed APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on viewshed resources would remain effectively permanent and therefore long term.

Light: The Project would impact viewshed resources from navigational and aviation lighting on offshore wind Project components. Impacts from construction and installation lighting would be most visible at night and from cultural resources that are along shorelines or on elevated locations with unobstructed views. A limited number of the 451 NRHP-eligible viewshed resources identified in the HRVEA would be affected and would include those for which the nighttime sky is a contributing element to aspects of its integrity, such as resources on the nearest shores of Rhode Island and Massachusetts and their offshore islands. The majority of the 451 resources with potential views of the Project, and therefore determined to be in the viewshed APE, are along the coastlines with potential ocean views. Of the 451 NRHP-eligible viewshed resources, 350 would experience **negligible** to **minor** visual impacts, not rising to the level of adverse effects under the criteria of NHPA Section 106 regulations (36 CFR 800.5); seven of these are NHLs that would not experience harm in consideration of NHPA Section 110(f). Of the 451 NRHP-eligible viewshed resources, 101 are anticipated to experience **moderate** to **major** visual impacts (daytime or nighttime) from the WTGs or OSSs that would rise to the level of adverse effect under NHPA Section 106 (see Table 3.10-6). Of the 101 aboveground historic properties that would be negatively affected to a moderate to major extent, five are NHLs, two are TCPs, and the remainder are historic buildings, structures, and districts.

In relation to the negatively affected viewshed resources, the Project could locate WTGs at approximately 6 miles from the Vineyard Sound and Moshup's Bridge TCP boundary offshore of Nomans Land Island and range to just over 28 miles from the Nobska Point Lighthouse near Falmouth, Massachusetts. Mostly, only the closer of the 101 moderately to majorly affected viewshed resources would have views of marine navigation lighting (consisting of flashing yellow lights) on WTGs or the OSSs. Increasing distances between viewshed resources and the nearest offshore RWF lighting sources would limit the intensity and begin eliminating negative lighting impacts at these 101 viewshed resources from red aviation warning lights atop WTG nacelles at distances beyond approximately 27 miles, based on postconstruction studies of the nearby BIWF's visibility at night (HDR 2019). See Section 3.10.1.3.1 for a discussion of how the intensity of lighting impacts would be reduced by proximity of existing light sources and atmospheric and environmental conditions. The use of an aircraft detection lighting system (ADLS) would substantially reduce the visual impact from Project lighting and make lighting visibility much more intermittent but would not eliminate the impact fully. Under the Proposed Action, lighting would have temporary to long-term **negligible** to **major** negative impacts on viewshed resources.

Presence of structures: The construction of the offshore Project components would result in modifications to the existing viewshed within the viewshed APE because a range of RWF WTG structures would be visible on the horizon from various viewshed resources on the shore during the daytime and structure lighting would be visible at night, as addressed in the Light impact discussion above (EDR 2023a; see also Section 3.20 for further discussion). Visibility of WTG structures would have long term, intermittent, and localized impacts, where and when not adequately obscured or diffused. Of the 451 NRHP-eligible viewshed resources identified by the HRVEA within the viewshed APE, 350 would have noncritical and/or limited views of WTGs. For a portion of the 350 resources, this is because the view to/from the resource's setting is not a critical aspect supporting the integrity of the viewshed resource for NRHP eligibility (EDR 2023b). For some of the other 350 resources, views are substantially limited because of screening by topography, vegetation, other buildings/structures, and environmental conditions (clouds, fog, and waves) compounded by distance to the offshore Project structures (EDR 2023b). These 350 NRHP-eligible viewshed resources would experience **negligible** to **minor** visual impacts not rising to the level of adverse effects under the criteria of NHPA Section 106; seven of these are NHLs that would not experience harm in consideration of NHPA Section 110(f). The remaining 101 NRHP-eligible viewshed resources of the 451 are anticipated to experience **moderate** to **major** visual impacts (daytime or nighttime) from the WTGs or OSS that would rise to the level of adverse effect under NHPA Section 106 (see Table 3.10-6). These 101 resources do have open ocean views that contribute to their significance, integrity, and NRHP eligibility. These 101 resources include five NHLs and two TCPs. The 101 resources also include historic districts that may encompass a range of contributing elements. As noted in the Lighting impacts discussion, the Project could locate WTGs approximately 6 miles from the nearest moderately to majorly affected NRHP-eligible viewshed resource at the Vineyard Sound and Moshup's Bridge TCP boundary offshore of Nomans Land Island. Moderate to major visual impacts from the Project would range to just over 28 miles at the negatively affected Nobska Point Lighthouse near Falmouth, Massachusetts. The distances between the areas with viewshed resources and the nearest RWF lighting sources would limit the intensity but not eliminate negative WTG visibility impacts to NRHP-eligible viewshed resources. Further moderating the visual impacts, the RWF WTGs would have consistent structural appearances (monopoles, three-rotor blades, and matching color schema), which contribute to a homogeneous view of wind farms on the horizon. The color of the RWF WTGs (less than 5% gray tone) would blend well with the sky at the horizon and eliminate the need for daytime lights or red paint marking the blade tips. For NRHP-eligible viewshed resources with ocean views important to their setting, the WTGs would be a new feature in the visual setting. Views in which strongly frontlit WTGs are viewed against a darker sky or strongly backlit WTGs were viewed against a light sky tend to heighten the visual impact, meaning the intensity of the effect may vary by time of day and year. Under the Proposed Action, the presence of offshore Project wind facilities would have long-term **negligible** to **major** negative impacts on viewshed resources.

Onshore Activities and Facilities

<u>Light</u>: Based on a field review of the viewshed analyses, the OnSS and ICF construction areas would be readily visible from two NRHP-eligible viewshed resources (EDR 2021a) within the viewshed APE; see further discussion under the Presence of structures section immediately below. For nighttime construction work, RWF would use portable, downward-facing floodlights with a maximum height of approximately 18 feet. The OnSS and ICF would largely blend with the existing Quonset Point Naval Air Station, would be partially obscured by other intervening residential development and vegetation, and would not introduce contrasting visual elements inconsistent with the existing setting of the Wickford Historic District (EDR 2021a). Temporary **negligible** negative impacts from lighting of onshore Project activities or facilities during construction and installation are expected on viewshed resources.

<u>Presence of structures</u>. For the onshore viewshed APE, construction and installation of the onshore Project facilities could introduce new visible elements to the setting of NRHP-eligible viewshed resources that would compromise their historic integrity, where there is an unimpeded line of sight between the resource and the onshore Project facilities. At the OnSS and ICF, Revolution Wind would use external yard lighting and task lighting, consisting of switched lights (in use if someone is in the yards), ranging from 35- to 300-watt lamps, depending on use. The mounting heights for the lighting would range from 10 to 25 feet off the ground, and lights would be mounted on lamp posts, substation buildings, firewalls,

or steel substation structures. The OnSS and ICF would be readily visible from two NRHP-eligible viewshed resources (EDR 2021a). From the OnSS and ICF location, the Wickford Historic District is 1.1 miles away and the Quonset Point Naval Air Station is 0.25 mile away.

The Quonset Point Naval Air Station is an approximately 974-acre World War II–era naval training facility improved with industrial buildings and parking lots that currently serves as a Rhode Island Air National Guard Base (EDR 2021a). The OnSS and ICF would be in scale and character with the existing development and use of the Quonset Point Naval Air Station. As a result of the construction and installation of the onshore Project facilities, the potential visual impacts to the NRHP-eligible Quonset Point Naval Air Station would be long term **negligible** to **minor** negative.

The Wickford Historic District retains eighteenth-century residences and its setting as a small-scale maritime community in Rhode Island. The Wickford Historic District remains primarily a residential community with some commercial buildings that support a seasonal recreation economy (EDR 2021a). The viewshed APE mostly reaches the area within the district along the Main Street pier. The OnSS and ICF would largely blend with the existing Quonset Point Naval Air Station; would be partially obscured by other intervening residential development and vegetation; and would not introduce contrasting visual elements inconsistent with the existing setting of the Wickford Historic District (EDR 2021a). As a result of the development of the onshore Project facilities, the potential visual impacts to the Wickford Historic District would be long term **negligible** to **minor** negative.

3.10.2.7.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Climate change: The impacts of the Proposed Action would be the same as the No Action Alternative as it relates to climate change and would be **negligible**. Refer to Section 3.10.1.1 for the No Action Alternative discussion. Although the degree to which future offshore wind activities would reduce the impacts of climate change on viewshed resources in the viewshed APE is unknown, impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on viewshed resources would remain effectively permanent and therefore long term.

Light: The visual impacts from WTG and OSS lighting described in construction and installation in Section 3.10.2.4.1 would persist through O&M activities at 101 NRHP-eligible viewshed resources, including five NHLs and two TCPs. Impacts would remain **negligible** to **minor** at the remaining 350 NRHP-eligible viewshed resources in the viewshed APE. However, for offshore WTGs, Revolution Wind would install ADLS technology. Consequently, nighttime visual impacts (and to a lesser degree, daytime visual impacts) to the 101 moderately to majorly affected viewshed resources would be reduced although not eliminated. Long-term **negligible** to **major** negative impacts would continue for viewshed resources during O&M. O&M would not add further to these impacts; however, removing WTGs and OSSs through decommissioning would provide a remedy to previous visual impacts created by lighting.

Presence of structures: This would be the same as for Project installation and construction through the life of the Project until decommissioning is complete. The visual impacts from offshore Project structures described for construction and installation in Section 3.10.2.4.1 would persist through O&M activities at 101 NRHP-eligible viewshed resources, including five NHLs and two TCPs, until the Project is decommissioned. Impacts would remain **negligible** to **minor** at the remaining 350 NRHP-eligible viewshed resources in the viewshed APE. **Negligible** to **major** negative impacts would continue for the long term at viewshed resources during O&M. O&M would not add further to these impacts; however, by removing WTGs and the OSS, decommissioning would provide a remedy to previous visual impacts created by visible offshore Project structures.

Onshore Activities and Facilities

Light: The impacts from light resulting from O&M activities associated with the Proposed Action would be the same as those described for Project installation and construction (see Section 3.10.2.4.1). Long-term **negligible** negative impacts from lighting of onshore Project activities or facilities are expected on viewshed resources from onshore activities and facilities.

Presence of structures: The impacts from the presence of structures resulting from O&M and decommissioning activities associated with the Proposed Action would be the same as those described for Project installation and construction (see Section 3.10.2.4.1). Although the NRHP-eligible Quonset Point Naval Air Station and Wickford Historic District are within the viewshed APE of the OnSS and ICF, these onshore Project facilities would be in scale and character with the current use of the Quonset Point Naval Air Station and would not introduce contrasting visual elements inconsistent with the existing setting of the Wickford Historic District. As a result of O&M and decommissioning of the onshore Project facilities, the potential visual impacts to the Quonset Point Naval Air Station and Wickford Historic District are anticipated to be long term **negligible** to **minor** negative.

3.10.2.7.3 Cumulative Impacts

Offshore Activities and Facilities

Climate change: Cumulative impacts of the Proposed Action as they relate to climate change would be the same as the No Action Alternative and would be **negligible**. Refer to Section 3.10.1.1 for the No Action Alternative discussion. Although the degree to which future offshore wind activities would reduce the impacts of climate change on viewshed resources in the viewshed APE is unknown, cumulative impacts from climate change are anticipated to remain **minor** to **moderate** negative even with the benefits of the Project since the ongoing effects of climate change on viewshed resources would remain effectively permanent and therefore long term.

Light: The Proposed Action would add offshore lighting impacts from navigational and aviation hazard lighting systems on the WTGs and OSSs. The addition would include up to 100 WTGs with red aviation hazard flashing lights and up to 100 WTGs and two OSSs with marine navigation lighting from RWF, compared to the future offshore wind activities' modeled maximum-case scenario of up to 955 WTGs and three OSS locations offshore of Rhode Island and Massachusetts (EDR 2021b). The 100 potential Project WTGs and two OSS locations represent, proportionally, nearly 10% to nearly 90% of the total cumulative offshore wind structures modeled as potentially visible from the 101 NRHP-eligible viewshed resources within the viewshed APE. The impacts of the Project and other future wind developments will vary and be relative to the position of each unique resource (SWCA 2023). Cumulatively, the Proposed Action when combined with past, present, and reasonably foreseeable activities could have intermittent and from temporary to long-term **negligible** to **major** negative impacts on viewshed resources.

Presence of structures: The Proposed Action would add up to 100 additional WTGs and up to two OSSs to the condition of the No Action Alternative within the viewshed APE, reaching a cumulative total of 1,055 WTGs and five OSS for the maximum-case scenario analysis.[34] The Project has the potential to add to cumulative visual effects on the 101 NRHP-eligible viewshed resources identified as negatively affected from a moderate to major degree by the Project, when combined with the potential effects of other past, present, or reasonably foreseeable future actions (SWCA 2023). The Project would introduce new elements to the viewshed that could compromise the historic integrity of NRHP-eligible viewshed resources. The maximum-case Project scenario would proportionally range from nearly 10% to nearly 90% of the total WTG and OSS locations modeled to be cumulatively visible from the 101 NRHP-eligible viewshed resources in the maximum-case scenario of all future wind energy development proposed in the viewshed APE. This is based on full build-out of the Project (to up to 100 WTGs and two OSSs) and all other reasonably foreseeable offshore wind projects currently planned in the APE (modeled at 955 WTGs and three OSS [EDR 2023b]). The proportion of visible WTG elements added by the Project ranges from nearly 10% at Vineyard Sound and Moshup's Bridge TCP (where all modeled WTGs and OSS would potentially be visible) to nearly 90% at the historic U.S. Weather Bureau Station at Block Island (where the Project WTGs would be visible in greater numbers than the combination of all other future wind farms planned in adjacent OCS lease areas [41 Project WTGs would be visible there versus six WTGs from other planned projects]) (SWCA 2023). Visual impacts to sensitive receptors from the Project would be long term and **negligible** to **major** negative, minimized with distance and obstructions. The Proposed Action when combined with past, present, and reasonably foreseeable activities would result in long-term **negligible** to **major** negative cumulative impacts on NRHP-eligible viewshed resources in the viewshed APE.

Onshore Activities and Facilities

Light: Long-term **negligible** negative impacts from lighting of onshore Project activities or facilities are expected on cultural resources in the viewshed APE, and these would not add cumulatively to the potential lighting impacts of other reasonably foreseeable activities.

Presence of structures: The Proposed Action's onshore facilities would not add cumulative impacts from the presence of structures resulting from other reasonably foreseeable activities.

3.10.2.7.4 Conclusions

Under the Proposed Action, the construction and installation of offshore Project components, as well as their O&M and decommissioning, would have long-term **negligible** to **major** negative impacts on viewshed resources. Long-term **negligible** to **minor** impacts would occur where visual impacts to NRHP-eligible viewshed resources could either be avoided or could be minimized to the extent that no adverse effect results under the NHPA Section 106 criteria (at 36 CFR 800.5). Long-term **moderate** to **major** negative impacts would be limited to unavoidable impacts to NRHP-eligible viewshed resources in the viewshed APE. These impacts would remain until removed with Project decommissioning.

[34] Please note that the modeling for the cumulative development of future offshore wind activities for viewshed resources (EDR 2021b), which is based on the maximum-case scenario of 955 WTGs (or 1,055 when RWF WTGs are included under the Proposed Action), carries over from and is retained for consistency with the CHRVEA (SWCA 2023); therefore, the number differs from the 999 WTG total for MA/RI leases (without the Proposed Action) that is presented for other resources in Table E3-1.

In the context of other reasonably foreseeable environmental trends and planned actions, the impacts to viewshed resources under the Proposed Action resulting from individual IPFs would range from long term **negligible** to **major** negative. Considering all the IPFs together, BOEM anticipates that the overall impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in **negligible** to **major** negative impacts to viewshed resources. Overall negative effects to NRHP-eligible viewshed resources in the viewshed APE would be avoided or minimized and mitigated in accordance with NHPA Section 106 regulations and, although long term, viewshed impacts would be removed upon Project decommissioning.

3.10.2.8 Alternatives C, D, E, and F: Marine Cultural Resources

Table 3.10-7 provides a summary of IPF findings for these alternatives.

3.10.2.8.1 Conclusions

Alternatives C through F would reduce the number of WTGs and, in relation, increase the distance of WTGs and their associated cabling from some of the 32 marine cultural resources identified. This decrease in WTGs would have an associated reduction in seafloor disturbance in the marine APE. This would increase the ability of the RWF to avoid Project impacts to seven marine cultural resources under Alternative C, one shipwreck site under Alternative D, and between two and seven marine cultural resources under Alternative E, as compared to the Proposed Action. Impacts to marine cultural resources resulting from the Alternative F would be somewhat less than the Proposed Action and, potentially, the other action alternatives, but this cannot be quantified until the additional WTGs to be removed are identified. However, because the potential for impacts to the remaining marine cultural resources remains the same, the avoidance of impacts to all marine cultural resources in the Lease Area would be similarly sought under the Proposed Action as under Alternatives C through F. Also, because all action alternatives have the same export cable development proposed, impacts to marine cultural resources would remain the same at the RWEC corridor. The construction and installation of offshore components, as well as their O&M and decommissioning, would have long term **negligible** to **major** negative impacts to marine cultural resources under all of these action alternatives.

In the context of other reasonably foreseeable environmental trends and planned actions and for the same reasons, BOEM also expects that Alternatives C through F's cumulative impacts to marine cultural resources would be similar to the Proposed Action: long term **negligible** to **major** negative.

3.10.2.9 Alternatives C, D, E, and F: Terrestrial Cultural Resources

Table 3.10-7 provides a summary of IPF findings for these alternatives.

3.10.2.9.1 Conclusions

Alternatives C through F would have the same Project activities and impacts in the terrestrial APE as the Proposed Action. BOEM expects that the impacts to terrestrial cultural resources resulting from Alternatives C through F would be the same as the Proposed Action. The construction and installation of onshore components, as well as their O&M and decommissioning, would have long-term **negligible** to **major** negative impacts to terrestrial cultural resources under any of the action alternatives.

In the context of other reasonably foreseeable environmental trends and planned actions, BOEM also expects that Alternatives C through F's cumulative impacts to terrestrial cultural resources would be the same as the Proposed Action: long term **minor** to **major** negative.

3.10.2.10 Alternatives C, D, E, and F: Viewshed Resources

Table 3.10-7 provides a summary of IPF findings for these alternatives.

3.10.2.10.1 Conclusions

Alternatives C through F could reduce the number of WTGs installed compared to the maximum-case scenario under the Proposed Action by 7% to 44% (depending on the action alternative combined with Alternative F), which would have proportional reductions in visual impacts. BOEM expects that the overall impacts to cultural resources in the viewshed APE resulting from Alternatives C through F would be similar in the number of viewshed resources impacted and the character of impacts to the Proposed Action; although, for Alternative E, the visual proximity for impacts from offshore Project elements would specifically have increased setbacks from viewshed resources at Martha's Vineyard and the nearest shores of Rhode Island. Alternative D3 would also remove the closest seven WTG locations to Block Island and have an increased advantage for reducing visual impacts on aboveground historic properties on the shores of that island over other action alternatives, except Alternative E2, which would remove even more WTGs, and Alternative G, which would remove a similar number of WTGs in different configurations, on the Block Island side of the RWF. While Alternative E2 would remove the closest WTGs to Martha's Vineyard, as well as being the most advantageous for reducing WTG proximity to Block Island, this alternative would not be as effective overall as Alternative E1 for reducing WTG proximity to onshore areas. The Alternative E1 configuration, in particular, would increase the overall distance of WTGs from Martha's Vineyard and toward mainland Rhode Island (see Figure 2.1-20); whereas, Alternative E2 (see Figure 2.1-21) would especially serve to decrease the frequency of silhouetted turbines visible from Aquinnah Overlook at sunset. Impacts to cultural resources in the viewshed APE resulting from Alternative F would be less than the Proposed Action and potentially the other action alternatives, but that cannot be quantified until the WTGs to be removed are identified. The construction and installation of offshore and onshore Project components, as well as their O&M and decommissioning, would have temporary to long-term **negligible** to **major** negative impacts to viewshed resources under any of the action alternatives. Decommissioning would remove these visual impacts. Overall, those action alternatives with the fewest WTGs and the greatest distances of setback would have the least degree of potential visual impacts on viewshed resources.

In the context of other reasonably foreseeable environmental trends and planned actions, BOEM also expects that Alternatives C through F's cumulative impacts to viewshed resources would be similar to the Proposed Action: long term **negligible** to **major** negative. Decommissioning would remove the cumulative visual impacts of the Project. As with Project-specific visual impacts on viewshed resources, those action alternatives with the fewest WTGs and the greatest distances of setback would have the least degree of potential cumulative impacts on viewshed resources.

3.10.2.11 Alternative G: Impacts of the Preferred Alternative on Marine Cultural Resources

Table 3.10-7 provides a summary of IPF findings for this alternative.

3.10.2.11.1 Conclusions

Alternative G would reduce the number of WTGs and, in relation, increase the distance of WTGs and their associated cabling from some of the 32 marine cultural resources identified, as compared to the Proposed Action, Alternative D, and Alternative E2, and would have approximately the same number of WTGs as Alternative C and Alternative E. This decrease in WTGs would have an associated reduction in seafloor disturbance in the marine APE (e.g., up to 2,619 acres of disturbance for IAC and OSS-link cable emplacement) under the Proposed Action as compared to 2,010 acres (23% less) under Alternative G. Although potentially greater than the other action alternatives, these reductions cannot be quantified for Alternative F because the additional Alternative F WTGs to be removed were not identified.

Reduction of disturbance areas would increase the ability of the RWF to further avoid Project impacts to 10 marine cultural resources under Alternative G as compared to seven marine cultural resources under Alternative C, one shipwreck site under Alternative D, and between two and seven marine cultural resources under Alternative E. However, because the potential for impacts to the remaining marine cultural resources remains the same, the avoidance of impacts to all marine cultural resources in the Lease Area would be similarly sought under the Proposed Action as under Alternative G and the other action alternatives. Also, because all action alternatives have the same export cable development proposed, impacts to marine cultural resources would remain the same at the RWEC corridor. The construction and installation of offshore components, as well as their O&M and decommissioning, would have long-term **negligible** to **major** negative impacts to marine cultural resources under Alternative G.

In the context of other reasonably foreseeable environmental trends and planned actions and for the same reasons, BOEM also expects that Alternative G's cumulative impacts to marine cultural resources would be similar to the Proposed Action: long term **negligible** to **major** negative.

3.10.2.12 Alternative G: Impacts of the Preferred Alternative on Terrestrial Cultural Resources

Table 3.10-7 provides a summary of IPF findings for this alternative.

3.10.2.12.1 Conclusions

Alternative G would have the same Project activities and impacts in the terrestrial APE as the Proposed Action and the other action alternatives. BOEM expects that the impacts to terrestrial cultural resources resulting from Alternative G would be the same under all action alternatives. The construction and installation of onshore components, as well as their O&M and decommissioning, would have long-term **negligible** to **major** negative impacts to terrestrial cultural resources under Alternative G.

In the context of other reasonably foreseeable environmental trends and planned actions, BOEM also expects that Alternative G's cumulative impacts to terrestrial cultural resources would be the same as the Proposed Action: long term **minor** to **major** negative.

3.10.2.13 Alternative G: Impacts of the Preferred Alternative on Viewshed Resources

Table 3.10-7 provides a summary of IPF findings for this alternative.

3.10.2.13.1 Conclusions

Alternative G could decrease impacts to viewshed resources when compared to the Proposed Action, Alternative D, and Alternative E2 because the number of constructed WTGs and their viewshed would be reduced by 35% for Alternative G as compared to the maximum-case scenario under the Proposed Action and by at least 20% as compared to maximum-case scenario under Alternative D and Alternative E2. The 35% reduction under Alternative G is comparable to the amount of reduction as would occur under Alternative C and Alternative E1, based on their WTG numbers; however, WTGs under Alternative G would be differently configured than under other alternatives. Finally, Alternative F would have 14% fewer WTGs than Alternative G, and the potential for an equivalent proportion of reduced visual impact on viewshed resources, although WTG setback distances changes cannot be quantified until the additional WTGs to be removed are identified under Alternative F.

Compared to the maximum-case scenario under the Proposed Action, Alternative G could decrease visual impacts to viewshed resources from RWF offshore facility visibility and the visibility of construction and installation lighting, primarily because the number of constructed WTGs and their viewshed would be reduced. However, the WTG configuration for Alternative G would also reduce the proximity of WTGs to Block Island and Martha's Vineyard and toward Newport and mainland Rhode Island (see Figure 2.1-22). Alternatives G1, G2, and G3 are similar to each other in terms of the reduction of WTGs in proximity to Martha's Vineyard and Block Island and toward Newport and mainland Rhode Island (see Figure 2.1-23, Figure 2.1-24, and Figure 2.1-25). Alternatives G1 and G2 would retain two WTGs closer to Martha's Vineyard, which Alternative G3 would remove, and Alternatives G1 and G3 would retain two WTGs closer to Block Island, which Alternative G2 would remove.

Alternatives G1, G2, and G3 would remove more of the closest WTGs to mainland Rhode Island and Newport, Martha's Vineyard, and Block Island when compared to the Proposed Action, Alternative C, and Alternatives D1 and D2. Alternatives G1, G2, and G3 would remove more of the closest WTGs to mainland Rhode Island, Newport, and Martha's Vineyard but retain a comparable amount near Block Island in comparison to Alternative D3. Alternatives G1, G2, and G3 would remove fewer of the closest WTGs to mainland Rhode Island, Newport, and Martha's Vineyard but retain a comparable—yet differently configured—amount near Block Island in comparison to Alternative E1. Alternatives G1, G2, and G3 would remove a comparable but differently configured amount of the closest WTGs to mainland Rhode Island, Newport, Martha's Vineyard, and Block Island in comparison to Alternative E2.

Although the distances and configurations of WTGs from Block Island, Martha's Vineyard, and mainland areas would vary under Alternative G from the other alternatives, the total number of WTGs under Alternative G would be greater than Alternative F; would remain similar to those of Alternative C and Alternative E1; and would be lower than the minimum number of WTGs planned under Action Alternatives B, D, and E2. Being one of the action alternatives with the lowest number of proposed WTGs, Alternative G—where increasing distances to WTGs from sensitive viewshed resources at the nearest points of land (Block Island, Martha's Vineyard, and Newport and mainland Rhode Island)—would more effectively reduce visual impacts than most other action alternatives. This especially includes distances increasing setbacks from viewshed resources important to Native American tribes at Aquinnah, inclusive of the Edwin DeVries Vanderhoop Homestead, Gay Head Light, and Gay Head - Aquinnah Shops. Alternative G would also further increase setbacks from Newport and Block Island, Rhode Island, including the Breakers, Marble House, and the Ocean Drive Historic District; Bellevue Avenue Historic District; and Southeast Lighthouse NHLs.

In relation to the five adversely affected NHLs, at Block Island and Newport, Rhode Island, Alternative G would reduce the field of view in which WTGs would be seen in a line across the horizon. Under Alternative G, Southeast Lighthouse NHL would have comparatively the narrowest visible extent of WTGs across the horizon, within a 24 to 26 degree field of view, as compared to a 29 degree field of view of WTGs under Alternative E, a 33 to 38 degree field of view of WTGs under Alternative D, and the broadest 38 degree field of view for the Project under Alternative C and under the Proposed Action (EDR 2023c). NHLs in the Newport area would have proportionately the fewest WTGs (a maximum of 65) in combination with a narrowed field of view (37 to 41 degrees) for WTGs visible across the horizon; although, the reduction is not as much as for the field of view from Block Island (EDR 2023c). Only Alternative D2 would have a narrower line of turbines visible from those NHLs at Newport, within a 35 to 37 degree field of view (EDR 2023c); however, Alternative D would have a cluster of up to 92 WTGs on the horizon, proportionately 42% more than Alternative G.

Compared to the Proposed Action, Alternative G setbacks for WTGs would increase the distances to viewshed resources at Aquinnah by a minimum of approximately 1.25 miles and at Newport and mainland Rhode Island by 1.15 mile and up to 3.5 miles, dependent on the WTG configuration used. In relation to Block Island, Alternative G would reduce the number of closest WTGs and remove the line of WTGs visible on the horizon from Block Island, removing the massing of WTGs at southeast and northeast of Block Island compared to the Proposed Action. Compared to Alternative C, Alternative G would continue to have WTGs in approximately the same proximity to Martha’s Vineyard, although Alternative G would have fewer WTGs than Alternative C. Alternative G would have approximately the same changes as Alternative C in relation to Block Island, Newport, and mainland Rhode Island (compared to the Proposed Action). Compared to Alternative D, Alternative G would have increased setbacks from Martha’s Vineyard, Newport, and mainland Rhode Island. However, compared to Alternative D3, Alternative G would have approximately the same increased setback distances from Block Island, albeit, with a different WTG configuration under Alternative G and Alternative D3. Alternative E1 would begin placing WTGs farther from Martha’s Vineyard and from Newport than Alternative G, with Alternative G WTG placement beginning approximately 2 miles nearer from Martha’s Vineyard and approximately 1.15 to 3.5 miles from Newport than the nearest Alternative E1 WTG. Alternative G would not reduce WTG proximity to Block Island as much as would Alternative E2 (where WTGs would begin at the same distance as Alternative G but then begin receding more greatly to the northwest, to distances of 1.15 miles to approximately 5.5 miles farther away). The distances by which Alternative F would increase WTG setbacks from shore in relation to the other action alternatives cannot be quantified until the additional WTGs to be removed are identified.

With the combination of reduced WTGs numbers and farther setbacks from shorelands, Alternative G would be more effective in reducing visual impacts from the nearest potential WTGs to viewshed resources at Martha’s Vineyard, on Block Island, and along Rhode Island shores compared to other action alternatives, except Alternative E and potentially Alternative F (where Alternative F reduces WTG numbers by up to 14% fewer than Alternative G). Nevertheless, Alternative G would not eliminate visual impacts to all viewshed resources and would not result in fewer visible WTGs and offshore RWF lighting sources than Alternatives C, E1, or F.

Although the level of impact would be reduced, the layout modification and construction activities proposed under Alternative G would still include the same viewshed resources visually impacted under the Proposed Action and the same potential for impacts to these resources. Portions of all RWF WTGs could be visible from most of the 101 NRHP-eligible viewshed resources moderately to majorly impacted under the action alternatives. All action alternatives, regardless of planned WTG numbers, would have WTG visibility reduced somewhat due to intervening land areas and with setback distance from coastlines. As described, those action alternatives with the fewest WTGs and the greatest distances of setback would have the least degree of potential visual impacts on viewshed resources. Under Alternative G, the construction and installation of offshore Project components would have temporary to long-term **negligible** to **major** negative impacts to viewshed resources, similar to those of the Proposed Action.

O&M and decommissioning of offshore Project components with lighting would have temporary to long-term **negligible** to **major** negative impacts to viewshed resources under Alternative G, similar to the Proposed Action. Impacts from Project lighting would be removed upon completion of decommissioning.

Regarding the potential 955 WTGs modeled in a maximum-case scenario for other future offshore wind activities (EDR 2021b), Alternative G would add more WTGs than Alternative F; fewer WTGs than the Proposed Action, Alternative D, and Alternative E2; and approximately the same number of WTGs as Alternative C and Alternative E1. Under Alternative G, the same 101 NRHP-eligible viewshed resources would continue to be negatively affected from a moderate to major degree by the offshore presence of structures in the viewshed APE as the other action alternatives (per the criteria of adverse effects in 36 CFR 800). The cumulative visual impacts on viewshed resources in the viewshed APE associated with Alternative G when combined with past, present, and reasonably foreseeable activities would be long term **negligible** to **major** negative until decommissioning of the Project. However, for Alternative G, the visual proximity for impacts from offshore Project elements would specifically have increased setbacks from viewshed resources at Martha's Vineyard, on Block Island, and the nearest shores of Newport compared to the other action alternatives, except under Alternative E.

3.10.2.14 Mitigation

Mitigation measures for cultural resources are addressed in Appendix F, Tables F-2 and F-3, and are in the memorandum of agreement (MOA), and its historic property treatment plans attached in Appendix J. Revolution Wind–committed measures identified in COP Appendix BB (Cultural Resources Avoidance, Minimization, and Mitigation Measures) would also be incorporated by BOEM into COP approval.

Pursuant to NHPA Section 106, the MOA and its requirements would be agreed to by the signatories, and BOEM would incorporate the MOA's requirements as appropriate as conditions of COP approval. Under the MOA, adverse effects from the Project to NRHP-eligible cultural resources, including NHLs and TCPs, would be avoided, minimized, or mitigated in accordance with the NHPA Section 106 regulations (36 CFR 800) and in compliance with Section 110(f).

3.11 Demographics, Employment, and Economics

3.11.1 Description of the Affected Environment for Demographics, Employment, and Economics

Geographic analysis area: The GAA for demographics, employment, and economics includes all of the ports listed in the COP as being potentially used during Project construction or operations, as shown in Figure 3.11-1. The figure also includes the top 11 commercial fisheries ports as described in Section 3.9 (all of which generated an average of over $5,000 per year in revenues from the Lease Area and the area affected by the RWEC).

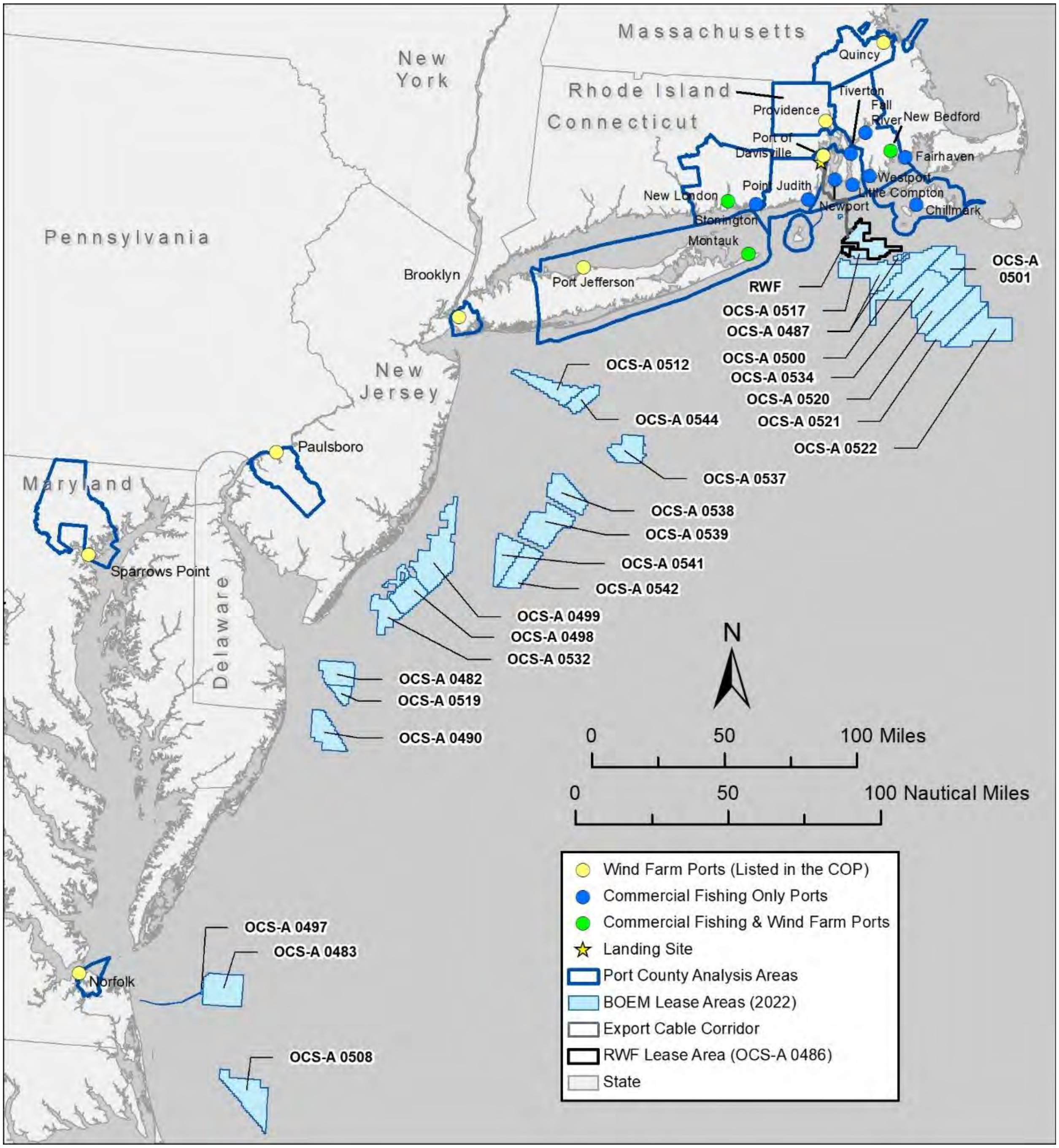


Figure 3.11-1. Geographic analysis area for demographics, employment, and economics.

Table 3.11-1 shows the ports listed in the COP as being potentially used to support construction or operations of the Proposed Action, and the wind farm–related activities that could occur at each port. Section 3.3.10 of the COP indicates that Revolution Wind has not made a final decision regarding the specific ports that would be used to support offshore construction, assembly and fabrication, crew transfers, and logistics. Section 3.5.6 of the COP notes that the Project is evaluating the use of the Port of Davisville at Quonset Point, Port Jefferson, Port of Montauk, and Cashman Shipyard to support O&M of the Project and other offshore wind energy projects. Table 3.11-1 also includes the top 10 commercial fishing ports that received landings harvested from within the Lease Area as described in Section 3.9.

Affected Environment: This subsection describes demographic characteristics and trends in the GAA. Table 3.11-2 describes each potentially affected county and city/town in terms of its area in square miles, population change between 2010 and 2020, population density, and median household income. A change in population has the potential to drive beneficial or adverse changes in other socioeconomic variables such as availability of housing and demand for public infrastructure and services.

Among the potentially affected counties, Kings County, New York, had the largest population, with over 2.7 million residents, as well as the highest population density. Within the GAA, Dukes County, Massachusetts, had the largest gain among counties, with nearly a 25% increase since 2010, whereas Montauk had the largest population gain among cities/towns with an increase of 30%. Five of the listed cities and towns experienced population declines between 2010 and 2020—New London and Stonington in Connecticut, Narragansett and Little Compton in Rhode Island, and Norfolk City in Virginia.

Table 3.11-1. Ports, Cities/Towns, Counties, and States in the Geographic Analysis Area

Port/ Facility Name/ Place Name	City/Town	County, State	WTG Tower, Nacelle and Blade Storage, Pre-Commissioning and Marshalling	Foundation Marshalling and Advanced Foundation Component Fabrication	Construction Hub and/or O&M Activities	Commercial Fishing
Port of New London	New London	New London, CT	X			X
Stonington	Stonington	New London, CT				X
Fairhaven	Fairhaven	Bristol, MA				X
New Bedford Marine Commerce Terminal	New Bedford	Bristol, MA	X			X
Westport	Westport	Bristol, MA				X
Chilmark/ Menemsha	Chilmark	Dukes, MA				X
Cashman Shipyard	Quincy	Norfolk, MA			X	
Sparrow's Point	Edgemere	Baltimore, MD		X		
Paulsboro Marine Terminal	Paulsboro	Gloucester, NJ	X	X		
Port of Montauk	Montauk	Suffolk, NY			X	X
Port Jefferson	Brookhaven	Suffolk, NY			X	
Port of Brooklyn	Brooklyn	Kings, NY			X	
Port of Providence*	Providence	Providence, RI	X	X		
Point Judith	Narragansett	Washington, RI				X
Port of Davisville at Quonset Point	North Kingstown	Washington, RI			X	
Newport	Newport	Newport, RI				X

Port/ Facility Name/ Place Name	City/Town	County, State	WTG Tower, Nacelle and Blade Storage, Pre-Commissioning and Marshalling	Foundation Marshalling and Advanced Foundation Component Fabrication	Construction Hub and/or O&M Activities	Commercial Fishing
Little Compton	Little Compton	Newport, RI				X
Port of Norfolk/ Norfolk International Terminal	Norfolk	Norfolk City, VA	X			

Sources: Developed based on data from Table 3.3.10-1 in the COP (for ports directly related to the Project) and data from NMFS (2021).

Note: CT = Connecticut, MA = Massachusetts, MD = Maryland, NJ = New Jersey, NY = New York, RI = Rhode Island, VA = Virginia.

* The Port of Providence is also designated as the location of "electrical activities and support" in the COP.

Table 3.11-2. Population and Median Income by City/Town and County

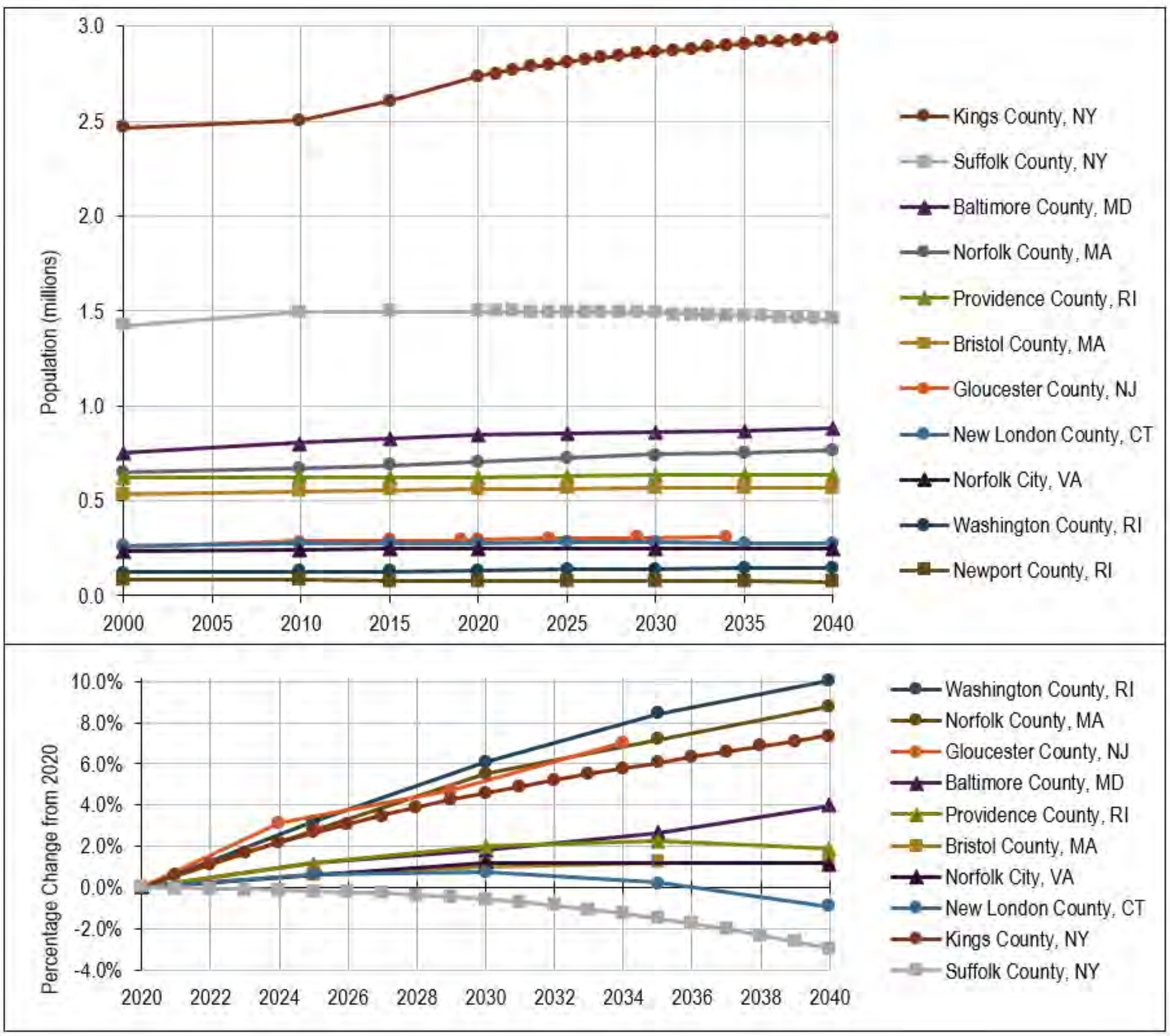
State/County/City or Town		Land Area (square miles)	Population (2010)	Population (2020)	Population Percent Change (2010–2020)	2020 Population Density (population/ square mile)	Median Household Income (2019)
Connecticut	New London County	665	274,055	268,555	-2.0%	404	$73,490
	New London	6	27,620	27,367	-0.9%	4,870	$46,298
	Stonington	39	18,545	18,335	-1.1%	474	$81,667

State/County/City or Town		Land Area (square miles)	Population (2010)	Population (2020)	Population Percent Change (2010–2020)	2020 Population Density (population/ square mile)	Median Household Income (2019)
Massachusetts	Bristol County	553	548,285	579,200	5.6%	1,047	$69,095
	New Bedford	20	95,072	101,079	6.3%	5,054	$46,321
	Fairhaven	12	15,873	15,924	0.3%	1,291	$67,394
	Westport	50	15,532	16,339	5.2%	328	$79,895
	Dukes County	103	16,535	20,600	24.6%	200	$71,811
	Chilmark/ Menemsha	19	866	930	7.4%	49	$96,471
	Norfolk County	396	670,850	725,981	8.2%	1,833	$103,291
	Quincy	17	92,271	101,636	10.1%	6,132	$77,562
Maryland	Baltimore County	598	805,029	854,535	6.1%	1,428	$76,866
	Edgemere	11	8,669	9,069	4.6%	837	$80,307
New Jersey	Gloucester County	322	288,288	302,294	4.9%	939	$87,283
	Paulsboro Borough	2	6,097	6,196	1.6%	3,261	$45,450
New York	Kings County (Brooklyn Borough)	71	2,504,700	2,736,074	9.2%	38,634	$60,231
	Suffolk County	912	1,493,350	1,525,920	2.2%	1,673	$101,031
	Montauk	17	3,326	4,318	29.8%	247	$96,389
	Port Jefferson	3	7,750	7,962	2.7%	2,602	$111,442

State/County/City or Town		Land Area (square miles)	Population (2010)	Population (2020)	Population Percent Change (2010–2020)	2020 Population Density (population/ square mile)	Median Household Income (2019)
Rhode Island	Providence County	410	626,667	660,741	5.4%	1,614	$58,974
	Providence	18	178,042	190,934	7.2%	10,377	$45,610
	Washington County	329	126,979	129,839	2.3%	394	$85,531
	Narragansett	14	15,868	14,532	-8.4%	1,046	$86,920
	North Kingstown	43	26,486	27,732	4.7%	643	$91,796
	Newport County	102	82,888	85,643	3.3%	836	$79,454
	Newport	8	24,672	25,163	2.0%	3,281	$67,102
	Little Compton	21	3,492	3,462	-0.9%	169	$89,353
Virginia	Norfolk City	54	242,803	238,005	-2.0%	4,398	$51,590

Sources: Unless otherwise noted, data are developed from U.S. Census Bureau (2021a). Data for Chilmark, Massachusetts, are from Wikipedia (2021a), Census Reporter (2021), and U.S. Census Bureau (2021b). Data for Montauk, New York, are from Wikipedia (2021b), Census Reporter (2021), and U.S. Census Bureau (2023). Data for Little Compton, Rhode Island, are from Wikipedia (2021c), Census Reporter (2021), and U.S. Census Bureau (2021b). Population data for Norfolk County, Massachusetts, and Quincy Massachusetts, are from U.S. Census Bureau (2022), and household income data are from U.S. Census Bureau (2020).

Figure 3.11-2 shows past and forecasted trends in population through 2040 for the counties in the GAA. The top panel contains population count forecasts, and the lower panel shows the projected future percentage change from the 2020 population estimate. Although the available population forecasts do not all use the same base year or the same set of assumptions with respect to future changes, they generally represent the best publicly available information. Four counties (Washington County, Rhode Island; Gloucester County, New Jersey; Kings County, New York; and Baltimore County, Maryland) have forecasts with increasing populations throughout the 20-year period. Population forecasts for four counties increase initially but then flatten while still remaining greater than 2020 (Dukes County, Massachusetts, Providence County, Rhode Island; Bristol County, Massachusetts; and Norfolk County, Virginia). Lastly, three counties are projected to see populations decline in the long run (New London County, Connecticut; Suffolk County, New York; and Newport County, Rhode Island).



Note: Figure panels developed using data from sources listed below.

Sources: Connecticut State Data Center (2018); Cornell Program on Applied Demographics (2018); Demographics Research Group (2019); Maryland State Data Center (2020); New Jersey Dept. of Labor and Workforce Development (2014); Rhode Island Statewide Planning Program (2013); UMASS Donahue Institute (2018).

Figure 3.11-2. Population trends and forecasts of counties in the analysis area (2000–2040).

3.11.1.1 Economic Characteristics within the Geographic Analysis Area

This subsection summarizes economic characteristics of counties and states in the GAA, including gross domestic product (GDP) and employment. The GDP values represent the market value of goods and services produced by the labor and property located within a geographic area, but they do not include the value of intermediate or used goods in the area. A focus of this analysis is the GDP for the "ocean economy," which includes economic activity dependent upon the ocean, such as 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 ocean-related tourism and recreation (National Ocean Economics Program 2022).

Most counties in the GAA display diverse economic activity, and many have well-developed ocean-based economic sectors. In particular, the ocean-related recreation and tourism sector plays a substantial role in many county economies affected by the Project (see Section 3.18). In addition, commercial fishing fleets are important to coastal communities because they generate employment and income for vessel owners and crews and create demand for shoreside products and services to maintain vessels and process seafood products (see Section 3.9). The marine transportation sector is expanding in some coastal counties, with the larger regional ports seeing increased vessel visits and undertaking upgrades to accommodate the increased utilization.

Table 3.11-3 summarizes trends in the annualized inflation-adjusted total GDP and ocean economy GDP of potentially affected states and counties. Among states, New York had both the largest total GDP and ocean economy GDP, and it experienced the largest increase in total GDP and ocean economy GDP from 2005 to 2020. Among counties, Kings County, New York, experienced a 67% increase in its ocean economy GDP from 2005 to 2020, and the ocean economy GDPs of Dukes County, Massachusetts; Gloucester, New Jersey; and Baltimore County, Maryland, also increased by more than 50%. Although Gloucester's ocean economy had a significant increase from 2005 to 2020, its overall economy declined by 16% in real terms. Norfolk City, Virginia, was the only city or county analyzed to experience a decline in both its overall economy and its ocean economy, with GDP declines of over 20% in real terms.

Table 3.11-3. Annualized Total and Ocean Economy Gross Domestic Product of Counties and States in the Geographic Analysis Area

State/County	2005 Total GDP (millions of 2020$)	2020 Total GDP (millions of 2020$)	2005–2020 Percent Change	Percentage of Analysis Area Total GDP in 2020	2005 Ocean Economy GDP (millions of 2020$)	2020 Ocean Economy GDP (millions of 2020$)	2005–2020 Percent Change	2020 Ocean Economy GDP as a Percentage of 2020 Total GDP
Connecticut	$266,827	$276,223	3.5%	6.5%	$3,802	$4,769	20.3%	7.4%
New London County	$20,164	$18,866	-6.4%	–	$1,787	$2,589	31.0%	–
Maryland	$340,791	$410,931	20.6%	9.7%	$5,627	$9,244	39.1%	14.3%
Baltimore County	$48,711	$55,989	14.9%	–	$316	$811	61.1%	–
Massachusetts	$444,671	$585,150	31.6%	13.8%	$5,491	$7,292	24.7%	11.3%
Bristol County	$23,109	$27,685	19.8%	–	$555	$1,057	47.5%	–
Dukes County	$1,296	$1,581	22.0%	–	$44	$101	56.1%	–
Norfolk County	$46,055	$54,512	18.4%	–	$386	$578	33.3%	–
New Jersey	$566,560	$620,086	9.4%	14.6%	$8,876	$10,927	18.8%	16.9%
Gloucester County	$16,184	$13,533	-16.4%	–	$209	$452	53.7%	–
New York	$1,321,086	$1,740,805	31.8%	41.0%	$20,261	$20,935	3.2%	32.5%
Kings County	$66,040	$107,034	62.1%	–	$639	$1,922	66.8%	–
Suffolk County	$83,879	$103,724	23.7%	–	$1,503	$2,270	33.8%	–

State/County	2005 Total GDP (millions of 2020$)	2020 Total GDP (millions of 2020$)	2005–2020 Percent Change	Percentage of Analysis Area Total GDP in 2020	2005 Ocean Economy GDP (millions of 2020$)	2020 Ocean Economy GDP (millions of 2020$)	2005–2020 Percent Change	2020 Ocean Economy GDP as a Percentage of 2020 Total GDP
Rhode Island	$57,697	$60,771	5.3%	1.4%	$2,369	$2,474	4.2%	3.8%
Providence County	$5,899	$6,432	9.0%	–	$691	$691	0.0%	–
Washington County	$34,132	$35,809	4.9%	–	$686	$648	-5.9%	–
Newport County	$6,445	$7,083	9.9%	–	$552	$744	25.8%	–
Virginia	$465,574	$556,993	19.6%	13.1%	$8,680	$8,847	1.9%	13.7%
Norfolk City	$24,483	$19,430	-20.6%	–	$1,424	$1,171	-21.5%	–
All States in the Geographic Analysis Area	**$3,463,206**	**$4,250,958**	**22.7%**	**100%**	**$55,105**	**$64,488**	**17.0%**	**100%**

Sources: National Ocean Economics Program (2022); U.S. Bureau of Economic Analysis (2022).

Note: A detailed list of economic sectors and industries that the National Ocean Economics Program defines as the ocean economy is available at https://www.oceaneconomics.org/Market/sectors.asp.

Table 3.11-4 summarizes the employment characteristics of counties and states with a potentially affected port, including the size of the labor force, the number of persons employed, and the unemployment rate in 2020. The size of the labor force in each county generally tracks the county's population size, with the largest labor force present in urban areas. Among counties, Kings County, New York, had the largest labor force in 2020, with 1.21 million participants, whereas Dukes County, Massachusetts, had the smallest labor force, with 9,552 participants. Likely a result of the COVID-19 pandemic, the percentage of the labor force that was unemployed was high throughout the GAA in 2020, with unemployment rates ranging from 6.2% in Virginia to 9.9% in New York. Unemployment in Gloucester County, New Jersey, was very high at 17.2% in 2020. By comparison, in 2019, Virginia and New York had unemployment rates of 2.8% and 3.8%, respectively, and Gloucester's rate of unemployment was 4.8%.

Table 3.11-4. Employment Characteristics of Potentially Affected States and Counties, 2020

State/County	Estimated Size of Labor Force	Estimated Number of Persons Employed	Percentage of Labor Force Unemployed
Connecticut	1,897,782	1,749,954	7.8%
New London County	133,743	121,093	9.5%
Massachusetts	3,741,686	3,390,253	9.4%
Bristol County	299,978	267,445	10.8%
Dukes County	9,542	8,598	9.9%
Norfolk County	390,023	355,614	8.8%
Maryland	3,227,527	3,012,107	6.7%
Baltimore County	452,245	421,646	6.8%
New Jersey	4,642,948	4,203,279	9.5%
Gloucester County	124,180	102,874	17.2%
New York	9,575,041	8,631,278	9.9%
Kings County	1,210,703	1,057,917	12.6%
Suffolk County	778,961	715,866	8.1%
Rhode Island	567,056	514,913	9.2%
Newport County	44,473	40,912	8.0%
Providence County	334,632	301,230	10.0%
Washington County	69,088	63,803	7.6%
Virginia	4,368,789	4,097,867	6.2%
Norfolk City	111,753	102,070	8.7%
States in GAA	28,020,829	25,599,651	8.6%
Counties in GAA	3,959,321	3,559,068	10.1%

Source: U.S. Bureau of Labor Statistics (2023).

3.11.2 Environmental Consequences

3.11.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

This assessment analyzes the maximum-case scenario; however, there is the potential for variances in the proposed Project build-out, as defined in the PDE (see Appendix D). From the perspective of potential Project impacts to demographic, employment, or economic conditions in the GAA, the key design parameters are total Project capacity, turbine size, and number of WTGs installed. If total Project capacity is larger and if similar-sized WTGs are used, then the number of WTGs must increase and the economic impacts during the construction phase would also increase. Similarly, if the number of WTGs is constant and the capacity of the individual turbines is larger (thus increasing the total capacity of the Project), then economic impacts during the construction phase would be greater. Economic impacts during the O&M phase are directly linked to total Project capacity. If total Project capacity increases, then total economic impacts during O&M would increase.

In addition, specified construction periods for individual Project components (inclusive of commissioning) affect the duration of economic impacts, while the selection of ports that support various Project activities and facilities will determine where economic impacts are likely to occur. Other factors that affect local economic impacts of the Project include the local and national Project Labor Agreements to which Revolution Wind has committed and the ability of local and U.S. industries to meet the manufacturing and component demands of the Project. These and other labor and construction practices for the Project are described in more detail in Appendix G and in Table F-1 in Appendix F.

See Appendix E1 for a summary of IPFs analyzed for demographics, employment, and economics across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have a negligible adverse effect are excluded from Chapter 3 and provided in Table E2-7 in Appendix E1.

Table 3.11-5 provides a summary of the generally beneficial employment, income, and value-added impacts of the alternatives along with the IPF findings carried forward for analysis in this section, which are generally considered adverse impacts. Each alternative analysis discussion consists of the construction and installation phase, the O&M phase, the decommissioning phase, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion. A detailed analysis of the Proposed Action is provided following the table. Detailed analysis of other considered action alternatives is also provided below the table if analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component.

The Conclusion section within each alternative analysis discussion includes a rationale for the effects determinations. Because there are both beneficial and adverse impacts, BOEM is unable to make a single overall impact determination with respect to demographics, employment, and economics.

Where feasible, calculations for specific alternative impacts are provided in Appendix E4 to facilitate reader comparison across alternatives.

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Table 3.11-5. Comparison of Evaluated Impact-Producing Factors under included Alternatives for Demographics, Employment, and Economics

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
Employment and economic activity generated by offshore wind energy	Under the No Action Alternative, BOEM estimates that 972 MW of offshore wind farm capacity would be installed and operational by 2024. Notwithstanding the above, the number of jobs created during offshore wind energy project construction and O&M would be small relative to the total number of jobs in the GAA. Therefore, the beneficial direct employment impacts of construction and O&M of future offshore wind energy projects would be localized, temporary to long term and **minor**. Impacts during project decommissioning would be similar to impacts during construction. There would be no further impacts once decommissioning is complete. Overall, offshore wind energy development is expected to have a short-term **negligible** to **minor** adverse impact on local supplies of labor and goods and services. Population increases from increased employment opportunities could reduce local housing availability and strain existing public infrastructure and services. Therefore, construction of offshore wind energy projects would have a short-term **negligible** to **minor** adverse impact on demographic-related variables such as housing availability and demand for public infrastructure and services.	Employment and economic activity impacts of the Proposed Action under the Large WTG Maximum Capacity Project configuration would be short term to long term **minor** beneficial. Construction would also have a short-term **negligible** adverse impact on local supplies of labor and goods and services and demographic-related variables such as housing availability and demand for public infrastructure and services for all design configurations analyzed under the Proposed Action. Decommissioning of the Project's offshore facilities is estimated to take 2 years. Because labor and contracting would account for a substantial portion of decommissioning costs, a relatively high percentage of decommissioning expenditures are expected to accrue to local economies. Therefore, decommissioning would have a short-term **minor** beneficial impact. Under the Proposed Action, BOEM estimates that annual average construction jobs from 2022 to 2030 would increase by 1.5% to 1.8% relative to the No Action Alternative, and that Project-related O&M jobs would increase by as much as 1.3% of all projected Atlantic Seaboard offshore wind O&M jobs in 2031. Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the employment and economic activity from the Project would have long-term **minor** beneficial impacts for demographics, employment, and economics.	See Section 3.11.2.4 for analysis. Under Alternative C, annual average offshore wind construction jobs from 2022 to 2030 would increase by 1.5% to 1.6%. Project-related O&M jobs would increase by as much as 1.3% of all Atlantic Seaboard offshore wind O&M jobs estimated for 2031. Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the employment and economic activity from Alternative C would have long-term **minor** beneficial impacts for demographics, employment, and economics.	See Section 3.11.2.4 for analysis. Under Alternative D, annual average offshore wind construction jobs from 2022 to 2030 would increase by 1.5% to 1.8%. Project-related O&M jobs would increase by as much as 1.3% of all Atlantic Seaboard offshore wind O&M jobs estimated for 2031. Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the employment and economic activity from Alternative D would have long-term **minor** beneficial impacts for demographics, employment, and economics.	See Section 3.11.2.4 for analysis. Under Alternative E, annual average offshore wind construction jobs from 2022 to 2030 would increase by 1.5% to 1.6%. Project-related O&M jobs would increase by as much as 1.3% of all Atlantic Seaboard offshore wind O&M jobs estimated for 2031. Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the employment and economic activity from Alternative E would have long-term **minor** beneficial impacts for demographics, employment, and economics.	See Section 3.11.2.4 for analysis. Under Alternative F, annual average offshore wind construction jobs from 2022 to 2030 would increase by 1.5% to 1.8%. Project-related O&M jobs would increase by as much as 1.2% of all Atlantic Seaboard offshore wind O&M jobs estimated for 2031. Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the employment and economic activity from Alternative F would have long-term **minor** beneficial impacts for demographics, employment, and economics.	See Section 3.11.2.5 for analysis. Under Alternative G, annual average offshore wind construction jobs from 2022 to 2030 would increase by 1.5%. Project-related O&M jobs would increase by as much as 1.2% of all Atlantic Seaboard offshore wind O&M jobs estimated for 2031. Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the employment and economic activity from Alternative G would have long-term **minor** beneficial impacts for demographics, employment, and economics.
Light	**Offshore**: The view of nighttime lighting could have impacts on employment and economic activity in the tourism industry by affecting the decisions of tourists in selecting coastal locations to visit (see Section 3.18). Impacts on businesses dependent on tourism would be localized short term **negligible** to **moderate** adverse during construction, O&M, and decommissioning based on the observed distance and individual responses by tourists to changes in the viewshed.	**Offshore:** The view of nighttime lighting during construction of offshore facilities could have impacts on employment and economic activity in the tourism industry by affecting the decisions of tourists in selecting coastal locations to visit (see Section 3.18). Impacts on businesses dependent on tourism would be localized and short term **negligible** to **moderate** adverse, based on the observed distance and individual responses by tourists to changes in the viewshed for all design configurations analyzed under the Proposed Action.	**Offshore:** By omitting certain WTG positions or eliminating WTGs adjacent to or overlapping certain transit lanes, Alternatives C through F would reduce the impact of light to the tourism industry. However, the light impact rating for recreation and tourism would be similar to the Proposed Action (see Section 3.18): short term negligible to moderate adverse for construction and long term negligible adverse for O&M and decommissioning. The lighting impact of Alternatives C through F on the tourism industry would not be markedly different from the Proposed Action (see Section 3.18). Therefore, cumulative impacts of light to demographic, employment, or economic conditions in the GAA would be similar to the Proposed Action: long term negligible to minor adverse if ADLS (or a similar system) is installed on WTGs.				**Offshore**: By omitting certain WTG positions or eliminating WTGs adjacent to or overlapping certain transit lanes, Alternative G would reduce the impact of light to the tourism industry. However, the light impact rating for recreation and tourism would be similar to the Proposed Action

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	If ADLS (or a similar system) is installed on WTGs, impacts to demographic, employment, or economic conditions in the GAA would be reduced to **negligible** to **minor** adverse.	Revolution Wind has committed to implement ADLS as a measure to reduce light impacts (see Table F-1 in Appendix F) and visual impacts on recreation and tourism during O&M. These impacts, while long term, are expected to be negligible adverse. Adverse impacts on businesses dependent on tourism would be localized and short term during construction and long term during operations, with negligible to moderate adverse impacts based on the observed distance and individual responses by tourists to changes in the viewshed. If ADLS (or a similar system) is installed on WTGs, impacts to demographic, employment, or economic conditions in the GAA would be reduced to negligible to minor adverse for all design configurations analyzed under the Proposed Action, as the amount of time WTGs would be visible at night would decrease (see Section 3.20).					(see Section 3.18): short term **negligible** to **moderate** adverse for construction and long term negligible adverse for O&M and decommissioning. The lighting impact of Alternative G on the tourism industry would not be markedly different from the Proposed Action (see Section 3.18). Therefore, cumulative impacts of light to demographic, employment, or economic conditions in the GAA would be similar to those under the Proposed Action: long term negligible to minor adverse if ADLS (or a similar system) is installed on WTGs.
New cable emplacement/ maintenance	**Offshore**: The impacts of new cable emplacement/maintenance to demographic, employment, and economic conditions in the GAA would be similar to those discussed below under the presence of structures IPF. The potential impacts of both IPFs include a decrease in employment or economic activity due to disruption to commercial fishing or for-hire recreational fishing businesses (see Section 3.9). The new cable emplacement and maintenance impact rating would be the same as the presence of structures impact rating: short term **minor** to **moderate** adverse.	**Offshore**: The impacts of new cable emplacement/maintenance to demographic, employment, and economic conditions in the GAA would be similar to those discussed below under the presence of structures IPF. The potential impacts of both IPFs include a decrease in employment or economic activity due to disruption to commercial fishing or for-hire recreational fishing businesses (see Section 3.9). Therefore, the new cable emplacement and maintenance impact rating would be the same as the presence of structures impact rating: short term adverse during construction/decommissioning and long term adverse during operations, as well as **minor** to **moderate** adverse.	**Offshore**: If the number of IACs is reduced under Alternatives C through F, the adverse economic impact of new cable emplacement on demographics, employment, and economics would be diminished. However, the new cable emplacement and maintenance impact rating for demographics, employment, and economics would be similar to that for the Proposed Action (see Section 3.9): short term **minor** to **moderate** adverse.				**Offshore**: If the number of IACs is reduced under Alternative G, the adverse economic impact of new cable emplacement on demographics, employment, and economics would be diminished. However, the new cable emplacement and maintenance impact rating for demographics, employment, and economics fishing would be similar to that for the Proposed Action (see Section 3.9): short term **minor** to **moderate** adverse.
Presence of structures	**Offshore**: Under the No Action Alternative, offshore wind energy development would result in the	**Offshore**: As described in Section 3.9, some individual operators of commercial fishing or for-hire recreational fishing businesses could	**Offshore**: By omitting certain WTG positions or eliminating WTGs adjacent to or overlapping certain transit lanes, Alternatives C through F would reduce the adverse economic impact of the presence of structures on demographics, employment, and economics. However, the presence of structures impact rating for				**Offshore**: By omitting certain WTG positions or eliminating WTGs

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	installation of an estimated 13,469 miles of offshore export cables and IACs and 3,088 offshore foundations. An analysis of the impacts of offshore wind energy structures, including WTGs and offshore submarine cables, to commercial fisheries and for-hire recreational fishing that could result from future offshore wind energy development is provided in Section 3.9. To the extent that the impacts of future offshore wind activities result in declines in the economic performance of commercial and for-hire recreational fisheries, workers employed in these fisheries, including fishing vessel crewmembers and seafood processor workers, could be adversely affected. Adverse impacts to demographic, employment, or economic conditions in the GAA would be short term and **minor** to **moderate**.	experience adverse economic impacts during Project construction and O&M as a result of the installation and presence of structures, including WTGs and OSSs. However, Revolution Wind's communication plans with the fishing industry would help ensure that fishing industry sectors, including harvesting operations, seafood processors and distributors, and shoreside support services, could continue to operate with minimal disruption. Therefore, adverse impacts to employment and economic activity in the fishing industry would be short to long term **minor** to **moderate** adverse. The Proposed Action in addition to other future offshore wind energy development would result in the installation of an estimated 13,716 miles of offshore export cables and IACs and 3,190 offshore foundations. Therefore, adverse economic impacts to commercial fisheries and for-hire recreational fishing would be short-term **minor** to **moderate** adverse during construction/decommissioning and long-term **minor** to **moderate** adverse during operations.	demographics, employment, and economics would be similar to the Proposed Action (see Section 3.9): short term to long term **minor** to **moderate** adverse.				adjacent to or overlapping certain transit lanes, Alternative G would reduce the adverse economic impact of the presence of structures on demographics, employment, and economics. However, the presence of structures impact rating for demographics, employment, and economics would be similar to that for the Proposed Action (see Section 3.9): short term to long term **minor** to **moderate** adverse.
Port utilization	**Onshore**: Offshore wind energy projects would require vessels for staging and installation during construction. This additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to high-demand port services (e.g., fueling and provisioning) for existing port users. Therefore, adverse impacts to demographic, employment, or economic conditions in the GAA during offshore wind energy project construction are expected to be localized, short term, and **minor** to **moderate**. Construction activities associated with port improvements would support marine service industries and provide employment opportunities for shore-based and marine workers. Overall, construction of port improvements related to offshore wind energy development would have long-term, **minor** to **moderate** beneficial impacts.	**Onshore**: The Proposed Action would require vessels for staging and installation during construction. This additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to high-demand port services (e.g., fueling and provisioning) for existing port users. Adverse port utilization impacts during offshore wind energy Project construction are expected to be localized, short term **minor** to **moderate** adverse. During Project O&M, port facilities would be required for vessels used for routine maintenance of offshore Project components. Given the relatively low number of vessels, the adverse impacts on the accessibility of port facilities would be long term **minor** adverse. Offshore wind energy projects, including the Proposed Action, would require vessels for staging and installation during construction, routine maintenance during operations, and deinstallation during decommissioning. This additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to high-demand port	**Onshore:** Construction of onshore facilities under Alternatives C through F would not be markedly different from the Proposed Action; therefore, impacts to demographic, employment, or economic conditions in the GAA would be the same as the Proposed Action: short term **minor** to **moderate** adverse for construction and decommissioning, long term **minor** adverse for O&M, and cumulatively long term minor to moderate adverse and beneficial.				**Onshore:** Construction of onshore facilities under Alternative G would not be markedly different from the Proposed Action; therefore, impacts to demographic, employment, or economic conditions in the GAA would be the same as the Proposed Action: short term **minor** to **moderate** adverse for construction and decommissioning, long term **minor** adverse for O&M, and cumulatively long term **minor** to **moderate** adverse and beneficial.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	During offshore wind energy project O&M, port facilities would be required for vessels used for routine maintenance of offshore project components. However, in comparison to the construction phases of projects, O&M would likely require a more limited number of vessels. Therefore, impacts would be long term and **minor** adverse. Offshore wind energy projects could generate employment opportunities and economic activity at ports used to support O&M of projects through port upgrades and development as well as marine transportation. Overall, the port investment and usage generated by offshore wind energy development would have long-term **minor** to **moderate** beneficial impacts.	services (e.g., fueling and provisioning) for existing port users. Cumulative port utilization impacts are expected to be **minor** to **moderate** adverse, localized, and short term during construction and decommissioning and long term during operations. Any the port investment and usage generated by offshore wind energy development would also have long-term **minor** to **moderate** beneficial impacts to demographic, employment, or economic conditions in the GAA.					
Vessel traffic	**Offshore**: Vessel traffic related to offshore wind energy project construction and O&M could cause congestion and delays. In addition, the risk of collisions that result in costly vessel damage and loss could increase. These vessel traffic changes would represent a short-term **minor** to **moderate** adverse impact to demographic, employment, or economic conditions in the GAA. In comparison to the construction phases of projects, a more limited number of vessels would likely be required for routine maintenance during the operations phase. Therefore, the reduction of vessel traffic would represent a long-term **negligible** to **minor** adverse impact.	**Offshore**: Vessel traffic related to offshore wind energy Project construction could cause congestion and delays, thereby increasing vessel fuel costs (i.e., for vessels forced to wait for port traffic to pass) and decreasing productivity for commercial shipping businesses. In addition, the risk of collisions that result in costly vessel damage and loss could increase (see Section 3.16). These vessel traffic changes would represent a short-term **minor** to **moderate** adverse impact. Project O&M would require a more limited number of vessels, and most of the vessels would be smaller in size (VHB 2023). Therefore, the adverse impacts of vessel traffic to demographic, employment, or economic conditions in the GAA would be long term **minor** adverse. The cumulative impacts of vessel traffic to demographic, employment, or economic conditions in the GAA would be short term **minor** to **moderate** adverse during construction/ decommissioning and long term **negligible** to **minor** adverse during operations.	**Offshore**: Under Alternatives C through F, vessel traffic would be similar to the Proposed Action (see Section 3.16). Therefore, the impact to demographic, employment, or economic conditions in the GAA would be similar to the Proposed Action: short term **minor** to **moderate** adverse for construction and decommissioning, long term **minor** adverse for O&M, and cumulatively short term **minor** to **moderate** during construction and decommissioning and long term **minor** during operations.				**Offshore**: Under Alternative G, vessel traffic would be similar to the Proposed Action (see Section 3.16). Therefore, the impact to demographic, employment, or economic conditions in the GAA would be similar to that for the Proposed Action: short term **minor** to **moderate** adverse for construction and decommissioning, long term **minor** adverse for O&M, and cumulatively short term **minor** to **moderate** during construction and decommissioning and long term **minor** during operations.
Vehicular traffic	**Onshore**: Activities associated with construction and O&M of the onshore and offshore facilities of offshore wind energy projects would result in temporary, localized traffic delays along impacted	**Onshore**: Some materials and equipment would arrive by land at varying frequencies throughout the construction period. This additional traffic could result in temporary, localized traffic delays that impact nearby businesses. Construction and	**Onshore**: Construction and operation of onshore facilities under Alternatives C through F would not be markedly different from the Proposed Action; therefore, impacts to demographic, employment, or economic conditions in the GAA would be the same as the Proposed Action: short term to long term **negligible** to **minor** adverse.				**Onshore**: Construction and operation of onshore facilities under Alternative G would not be markedly different

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	roads (see Section 3.14). Adverse effects of the additional vehicular traffic to demographic, employment, or economic conditions in the GAA would be short term to long term **negligible** to **minor adverse**.	O&M of the onshore facilities of the Proposed Action could also result in temporary, localized traffic delays that impact nearby businesses (see Section 3.14). On this basis, the overall effects of vehicular traffic would be short term to long term and **negligible** to **minor** adverse.					from the Proposed Action; therefore, impacts to demographic, employment, or economic conditions in the GAA would be the same as the Proposed Action: short term to long term **negligible** to **minor** adverse.

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3.11.2.2 Alternative A: Impacts of the No Action Alternative on Demographics, Employment, and Economics

3.11.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for demographics, employment, and economics (see Section 3.11.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind projects within the GAA. These IPFs are described and analyzed in Appendix E1.

Other ongoing activities within the GAA, including non–offshore wind activities that contribute to impacts on demographics, employment, and economics within the GAA, include the following:

- Continued O&M of the BIWF project installed in state waters of Rhode Island with a capacity to generate 30 MW
- Continued O&M of the Coastal Virginia Offshore Wind project installed off the coast of Virginia with a generating capacity of 12 MW
- Ongoing construction of the Vineyard Wind 1 project off the coast of Massachusetts with a projected capacity of 800 MW and an expected completion date in 2023, with O&M activities continuing into the future
- Ongoing construction of the SFWF project off the coast of New York with a projected capacity of 132 MW and an expected completion in 2023, with O&M activities continuing into the future

Table 3.11-6 summarizes the number of estimated offshore wind jobs occurring within the GAA under the No Action Alternative. Construction jobs are projected for the years 2022 and 2023 when construction of the Vineyard Wind 1 and SFWF projects are expected to be completed. O&M jobs are listed beginning in the year of completion of project construction. The O&M jobs shown for 2022 are the estimated number of jobs resulting from continued operations of the BIWF and Coastal Virginia Offshore Wind projects. All estimates of jobs show direct jobs (jobs directly linked to project). Indirect jobs are jobs generated by purchases of labor and materials from independent suppliers to projects, whereas induced jobs are jobs within the GAA that are generated by the household spending of direct and indirect employees and company owners.

This analysis uses the Jobs and Economic Development Impacts Offshore Wind Model (JEDI-OWM) developed by National Renewable Energy Laboratory (NREL) (2017) to estimate the potential economic impacts of offshore wind energy development within the GAA.[35] The primary data inputs for the JEDI-

[35] The JEDI-OWM is an interactive spreadsheet model developed and maintained by the NREL (NREL 2017, 2021). JEDI-OWM (Release 1.05.2017) was used in Hamilton and Nubbe (2020) to generate estimates of the economic impacts of the Project, as reported in the COP. As described in Appendix G, the current version of JEDI-OWM (Release 2021-2) (NREL 2021)—which includes the ability to estimate project capital costs with three alternative WTG capacities (6 MW, 10 MW, and 15 MW)—was used as a data source for capital costs of various sizes of WTGs. These capital cost estimates were then input into JEDI-OWM (Release 1.05.2017) to generate estimates of remaining capital costs and operations and maintenance costs, as well as the economic impacts (direct, indirect, and induced) for employment, income, total output, and value-added. It should be noted that unlike the 2017 release, JEDI-OWM Release 2021-2 does not include estimates of local purchase coefficients that allow the JEDI-OWM to generate estimates of local economic impacts. Therefore JEDI-OWM Release 1.05.2017 was the primary model used for estimates of economic impacts.

OWM are based on generalized project design parameters described in Table E3-1 (parts 1–3) in Appendix E3.

Table 3.11-6. Estimated Ongoing Jobs in the Geographic Analysis Area under the No Action Alternative for Construction (2022–2023) and Operations and Maintenance (2021–2030)

Job Category	Projected Construction Jobs in 2022	Projected Construction Jobs in 2023	Projected Operations and Maintenance Jobs in 2022	Projected Operations and Maintenance Jobs in 2023	Projected Operations and Maintenance Jobs 2024–2030
Direct jobs	792	792	4	4	59
Indirect jobs	1,324	1,324	19	19	333
Induced jobs	889	889	8	8	131
Total jobs	**3,005**	**3,005**	**31**	**31**	**523**

Source: Estimates were developed using the JEDI-OWM (NREL 2017, 2021).

Note: Jobs during the period shown include preconstruction jobs. All jobs are defined as full-time equivalents (FTEs), or 2,080-hour units of labor (one construction period job equates to one full-time job for 1 year).

3.11.2.2.2 Cumulative Impacts

This section discusses potential demographics, employment, and economics impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E3.

Appendix E includes estimates of future offshore wind energy development along the U.S. east coast, including the number of WTGs and MW capacity that are projected to be installed and the timing of the construction period and projected years when operations would begin. Table E3-1 lists 33 separate offshore wind development projects that are in planning phases through 2030 in addition to the projects described in the previous section. Together, by 2030, these wind farms could add over 45 GW of renewable energy (excluding Revolution Wind) into the energy grid from Massachusetts to North Carolina using the same general geographic range of ports that has been specified in the COP for the Project.

3.11.2.2.3 Construction and Installation

Employment and Economic Activity Impacts of Construction and Installation

This analysis uses the JEDI-OWM developed by NREL (2017) to estimate the potential economic impacts of offshore wind energy development within the GAA. The JEDI-OWM does not have the ability to fully distinguish between the economic impacts of offshore versus onshore activities and facilities related to offshore wind energy development. Therefore, the economic impacts of future offshore wind energy projects (without the Proposed Action) predicted by the model are presented separately from the description of the impacts of the projects' offshore and onshore activities and facilities. The primary data inputs for the JEDI-OWM are based on information in Table E-1 in Appendix E and Project design parameters described in Table E3-1 in Appendix E3.

Table 3.11-7 shows projected employment from existing and future offshore wind developments within the GAA for the years 2021–2030 under the No Action Alternative as described in Table E3-1 (parts 1–3) in Appendix E3, excluding Revolution Wind. Most of the direct construction-related jobs would be attributed to either the community hosting the regional headquarters of the Project developer or the fabrication and storage ports that would be used. In general, the specific locations of the regional fabrication and storage ports for specific projects have not been announced, with the exception of New Bedford being selected for the Vineyard Wind project. It can also be inferred that most of the engineering and construction of both onshore and offshore facilities are included in the direct jobs, whereas most of the component fabrication, storage, and transport are included in the indirect jobs. The induced jobs effect occurs almost entirely onshore because income generated from the direct and indirect jobs is spent throughout the local economy.

Table 3.11-7. Estimated Jobs in the Geographic Analysis Area for Construction Activities of Ongoing Projects and Future Offshore Wind Farms (2023–2030)

Job Category	2022	2023	2024	2025	2026	2027	2028	2029	2030
Direct jobs	792	792	10,450	9,433	9,601	12,035	10,896	9,682	6,011
Indirect jobs	1,324	1,324	17,480	15,778	16,059	20,130	18,223	16,191	10,053
Induced jobs	889	889	11,732	10,590	10,779	13,513	12,233	10,869	6,749
Total jobs	**3,005**	**3,005**	**39,662**	**35,801**	**36,439**	**45,678**	**41,352**	**36,742**	**22,813**

Source: Estimates were developed using the JEDI-OWM (NREL 2017, 2021).

Note: Jobs during the period shown include preconstruction jobs. All jobs are defined as FTEs, or 2,080-hour units of labor (one construction period job equates to one full-time job for 1 year).

This future offshore wind energy development would create a demand for workers skilled in the professions and trades needed for the design, construction, and O&M of offshore wind energy facilities. From 2022 to 2030, it is conservatively estimated that an annual average of more than 29,000 jobs would be created as a result of the design and construction of offshore wind projects if direct, indirect, and induced jobs are included. Of these jobs, 26% are directly associated with offshore wind farm projects, 44% are indirectly associated with offshore wind farm projects through suppliers and contractors, and 30% are induced through the household spending from income generated by the direct and indirect jobs.

BVG Associates Limited (2017) analyzed the specific occupations required for offshore wind energy development in the United States. The occupations demanded included technician-level workers in 1) production roles, particularly high-value manufacturing positions; 2) installation and commissioning positions; 3) vessel and offshore equipment operation; and 4) commissioning and testing turbines, cables, and substations. Appendix G contains additional discussion and a figure (Figure G-DEM1) summarizing projected jobs by major occupational categories. The report notes that a particular value of offshore wind energy jobs is that many are created in industrialized coastal areas that have suffered from economic decline in recent years. Offshore wind could play an important part in reversing that situation. However, the number of jobs created during offshore wind energy project construction would be small relative to the total number of jobs in the GAA. Therefore, the beneficial direct employment impacts of construction of future offshore wind energy projects would be localized, temporary, and **minor**.

In communities with ports used for staging and fabrication, offshore wind energy development could temporarily compete with the local commercial fishing industry for marine workers. This competition could exacerbate current fishing industry labor shortages. Recent studies (e.g., Johnson and Mazur 2018) show that some commercial fisheries in the New England and Mid-Atlantic regions face workforce challenges, with a lack of young people entering the industry. In addition, the increased economic activity during the construction phase of offshore wind energy projects could temporarily increase competition for some onshore facilities and services, thereby resulting in higher prices for these facilities and services. With an increase in prices, some businesses in the commercial fishing industry and other marine sectors could seek facilities and services in ports not supporting offshore wind development. Overall, offshore wind energy development is expected to have a short-term **negligible** to **minor** adverse impact on local supplies of labor and goods and services.

The increased employment opportunities created during construction of offshore wind energy projects could result in population increases in those communities with ports used for staging and fabrication of projects. In turn, these population increases could reduce local housing availability and strain existing public infrastructure and services. However, although some non-local workers could need temporary housing depending on the ports selected, it is expected that most of the workers involved in the installation of the offshore wind energy facilities would be housed onboard vessels and would be expected to work for several weeks at sea before returning to shore. These conditions suggest that offshore construction crews would have little incentive to relocate to a port community. Therefore, construction of offshore wind energy projects would have a short-term **negligible** to **minor** adverse impact on demographic-related variables such as housing availability and demand for public infrastructure and services.

In addition to supporting the employment described above, BOEM expects construction of future offshore wind energy projects to affect demographics, employment, and economics through the following IPFs.

Offshore Activities and Facilities

Light: The view of nighttime lighting during construction of offshore wind energy structures could have adverse impacts on employment and economic activity in the tourism industry by affecting the decisions of tourists in selecting coastal locations to visit (see Section 3.18). Impacts on businesses dependent on tourism would be localized short term **negligible** to **moderate** adverse based on the observed distance and individual responses by tourists to changes in the viewshed.

New cable emplacement/maintenance: The impacts of new cable emplacement/maintenance to demographic, employment, and economic conditions in the GAA would be similar to those discussed below under the presence of structures IPF. The potential impacts of both IPFs include a decrease in employment or economic activity due to disruption to commercial fishing or for-hire recreational fishing businesses (see Section 3.9). Therefore, the new cable emplacement and maintenance impact rating would be the same as the presence of structures impact rating: short term **minor** to **moderate** adverse.

Presence of structures: An analysis of the impacts of construction of offshore wind energy structures, including WTGs and offshore submarine cables, to commercial fisheries and for-hire recreational fishing that could result from future offshore wind energy development is provided in Section 3.9. To the extent that the impacts of future offshore wind activities result in declines in the economic performance of commercial and for-hire recreational fisheries, workers employed in these fisheries, including fishing vessel crewmembers and seafood processor workers, could be adversely affected. However, WTG spacing and orientation measures, offshore cable burial, financial compensation programs for fishing interests, and other mitigation measures implemented by offshore wind developers, together with the ability of fishing vessel operators to adjust transit and fishing locations to avoid conflicts with construction related to offshore wind energy development, would help ensure that fishing businesses could continue to operate with limited disruption. Therefore, impacts to demographic, employment, or economic conditions in the GAA would be short term **minor** to **moderate** adverse.

<u>Vessel traffic</u>: Vessel traffic related to offshore wind energy project construction could cause congestion and delays, thereby increasing vessel fuel costs (i.e., for vessels forced to wait for port traffic to pass) and decreasing productivity for commercial shipping businesses. In addition, the risk of collisions that result in costly vessel damage and loss could increase. These vessel traffic changes would represent a short-term **minor** to **moderate** adverse impact to demographic, employment, or economic conditions in the GAA.

Onshore Activities and Facilities

<u>Port utilization</u>: Offshore wind energy projects would require vessels for staging and installation during construction. This additional vessel volume could cause delays or changes in berthing patterns at ports, and it could result in reduced access to high-demand port services (e.g., fueling and provisioning) for existing port users. However, state and local agencies would be responsible for minimizing the potential adverse impacts of additional port utilization by managing traffic to ensure continued access to port facilities (see Section 3.16). In addition, the use of multiple ports to support offshore wind energy project development would reduce the related congestion impacts in any one port. Therefore, impacts to demographic, employment, or economic conditions in the GAA during offshore wind energy project construction are expected to be localized and short term **minor** to **moderate** adverse.

Some ports could undertake upgrades to support offshore wind energy development. These types of upgrades are described in Appendix E. In addition, see Whitney et al. (2016) for a summary of the current status of U.S. ports, as well as some of the planned and implemented port expansions to further support offshore wind energy development. The construction activities associated with these port improvements would support marine service industries and provide employment opportunities for shore-based and marine workers. Overall, construction of port improvements related to offshore wind energy development would have long-term **minor** to **moderate** beneficial impacts to demographic, employment, or economic conditions in the GAA.

<u>Vehicular traffic</u>: Activities associated with construction of the onshore and offshore facilities of offshore wind energy projects would result in temporary, localized traffic delays along impacted roads (see Section 3.14). These traffic delays could temporarily restrict access to adjacent commercial properties. State and local agencies would be responsible for managing actions to help minimize and avoid traffic delays and other impacts on nearby businesses during construction. On this basis, the adverse effects of the additional vehicular traffic to demographic, employment, or economic conditions in the GAA would be short-term **negligible** to **minor**.

3.11.2.2.4 Operations and Maintenance and Decommissioning

Employment and Economic Activity Impacts of Operations and Maintenance and Decommissioning

As discussed above, the JEDI-OWM does not have the ability to distinguish between the employment impacts of offshore versus onshore activities, and therefore the results of the model are presented in advance of the offshore and onshore discussion.

Table 3.11-8 shows projected employment from currently operating offshore wind farms along with future offshore wind energy projects within the GAA, excluding Revolution Wind.[36] The table includes years out through 2031 because operations for several projects are not expected to begin until 2030; by then, it is projected that there will be over 21,500 direct, indirect, and induced jobs in O&M in the offshore wind industry (NREL 2017, 2021). Most of the direct O&M-related jobs generated by offshore wind projects would occur in the projects' port communities and in the communities hosting the regional headquarters of project developers. O&M jobs would include turbine technicians and water transportation workers (BVG Associates Limited 2017). The number of jobs created during O&M activities of offshore wind energy projects would be small relative to the total number of jobs in the GAA. Therefore, the beneficial direct employment impacts during the O&M phases of future offshore wind energy projects would be localized and long term **minor**. Impacts during project decommissioning would be similar to impacts during construction. There would be no further impacts once decommissioning is complete.

Table 3.11-8. Estimated Jobs in the Geographic Analysis Area with Currently Active and Future Offshore Wind Farms (2023–2031)

Job Category	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Direct jobs	4	4	59	119	411	652	1,174	1,518	1,875	2,417
Indirect jobs	19	19	333	672	2,346	3,727	6,710	8,676	10,719	13,813
Induced jobs	8	8	131	263	914	1,451	2,609	3,372	4,166	5,368
Total jobs	31	31	523	1,054	3,671	5,830	10,493	13,566	16,760	21,598

Source: Estimates were developed using the JEDI-OWM (NREL 2017, 2021).

Note: All jobs are defined as FTEs, or 2,080-hour units of labor.

In addition to supporting the employment described above, BOEM expects O&M of future offshore wind energy projects to affect demographics, employment, and economics through the following IPFs.

Offshore Activities and Facilities

Light: The view of nighttime aviation warning lighting required for offshore wind energy structures could have impacts on employment and economic activity in the tourism industry by affecting the decisions of tourists or visitors in selecting coastal locations to visit (see Section 3.18). Impacts on businesses dependent on tourism would be localized and short term **negligible** to **moderate** adverse, based on the observed distance and individual responses by tourists to changes in the viewshed. If ADLS (or a similar system) is installed on WTGs, impacts to demographic, employment, or economic conditions in the GAA

[36] Employment estimates have been developed for all future projects (excluding Revolution Wind) in the Atlantic OCS as described in Table E3-1 (parts 1–4) in Appendix E3.

would be reduced to **negligible** to **minor** adverse because the amount of time WTGs would be visible at night would decrease (see Section 3.20).

New cable emplacement/maintenance: The impacts of new cable emplacement and maintenance to demographic, employment, and economic conditions in the GAA would be the same as the No Action Alternative (see Section 3.11.2.2.3) and as the presence of structures impact rating: short term **minor** to **moderate** adverse.

Presence of structures: Under the No Action Alternative, offshore wind energy development would result in the installation of an estimated 10,620 miles of offshore export cables and IACs and 3,113 offshore foundations[37] (excluding Revolution Wind). An analysis of the impacts of offshore wind energy structures, including WTGs and offshore submarine cables, to commercial fisheries and for-hire recreational fishing that could result from future offshore wind energy development is provided in Section 3.9. To the extent that the impacts of future offshore wind activities result in declines in the economic performance of commercial and for-hire recreational fisheries, workers employed in these fisheries, including fishing vessel crewmembers and seafood processor workers, could be adversely affected. However, WTG spacing and orientation measures, offshore cable burial, financial compensation programs for fishing interests, and other mitigation measures implemented by offshore wind developers, together with the ability of fishing vessel operators to adjust transit and fishing locations to avoid conflicts with construction related to offshore wind energy development, would help ensure that fishing businesses could continue to operate with limited disruption. Therefore, impacts to demographic, employment, or economic conditions in the GAA would be short term **minor** to **moderate** adverse.

Vessel traffic: Vessel traffic related to offshore wind energy project O&M would be similar to the construction phases of projects (see Section 3.11.2.2.3) except that a reduced number of vessels would be required for routine maintenance during the operations phase. Therefore, vessel traffic changes would represent a long-term **negligible** to **minor** adverse impact to demographic, employment, or economic conditions in the GAA.

Onshore Activities and Facilities

Port utilization: During offshore wind energy project O&M, port facilities would be required for vessels used for routine maintenance of offshore project components. These vessels would require berthing and would add traffic to port facilities. However, in comparison to the construction phases of projects, O&M would likely require a reduced number of vessels. Given the relatively low number of vessels, the impacts of the changes in port facility accessibility to demographic, employment, or economic conditions in the GAA would be long term **minor** adverse.

Offshore wind energy projects could generate employment opportunities and economic activity at ports used to support O&M of projects through port upgrades and development as well as marine transportation. Additional shore-based and marine workers would be hired, resulting in a trained workforce for the offshore wind energy industry. Moreover, port improvements would support and enhance other port activities. Overall, the port investment and usage generated by offshore wind energy

[37] These estimates of cable miles are based on Appendix E3, Table E3-1 (parts 1–3).

development would have long-term **minor** to **moderate** beneficial impacts to demographic, employment, or economic conditions in the GAA.

Vehicular traffic: Actions associated with O&M of the onshore and offshore facilities of offshore wind energy projects could result in localized traffic delays along impacted roads (see Section 3.14). However, the increase in traffic caused by projects is expected to be minimal and is not expected to disrupt normal business activities in the GAA. On this basis, the effects of the additional vehicular traffic to demographic, employment, or economic conditions in the GAA would be long term **negligible** to **minor** adverse.

3.11.2.2.5 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts associated with the Project would not occur. However, ongoing and future offshore wind activities and non–offshore wind activities would have continuing impacts on demographic, employment, and economic conditions in the GAA.

Considering all the IPFs together for offshore wind activities, BOEM anticipates that the overall impacts of future offshore wind energy development on demographic, employment, and economic conditions in the GAA would be short term during construction and long term during O&M and **moderate** adverse. This rating primarily reflects adverse impacts to employment and economic activity in commercial fisheries. Beneficial impacts of future offshore wind energy development would be short term during construction and long term during O&M; these beneficial impacts would be **minor**. This beneficial rating primarily reflects new job formation associated with offshore wind development.

Ongoing and future non–offshore wind activities as described in Appendix E would have long-term **major** adverse impacts on demographic, employment, and economic conditions in the GAA as a result of climate change and the associated risks of flooding, extreme heat, and storm damage. Ongoing and future non–offshore wind activities would also have long-term, **moderate** beneficial impacts on some local economies, driven primarily by the ongoing operation of existing marine industries in parts of the GAA, especially commercial fishing, recreation/tourism, and shipping.

BOEM anticipates that the impacts associated with future offshore wind activities in the GAA combined with ongoing and reasonably foreseeable activities other than offshore wind would be long term **major** adverse as a result of climate change. These **major** adverse impacts from climate change are driven by cumulative activities and trends. Long-term **moderate** beneficial impacts would occur in some local economies, representing notable and measurable improvements as a result of ongoing economic development.

3.11.2.3 Alternative B: Impacts of the Proposed Action on Demographics, Employment, and Economics

3.11.2.3.1 Construction and Installation

Employment and Economic Activity Impacts of Construction and Installation

The analysis in this section is based on the economic analysis of the impacts of construction and operations of the Project described in the COP, and on additional information provided in Appendix CC to the COP (Hamilton and Nubbe [2020]), which has been deemed confidential by Revolution Wind. The

COP and Appendix CC develop impact estimates for a single Project configuration with a total nameplate capacity of 712 MW that would use 89 8-MW WTGs, with jobs, labor income, and value-added apportioned between Rhode Island and Connecticut. Additional economic impacts are expected in other unspecified locations within the United States. In the assessment that follows, this configuration is referred to as the "Baseline Project." Additional information on the estimation of economic impacts during the construction and operation phases can be found in the Demographics, Employment, and Economics section of Appendix G.

Although the Proposed Action could be configured exactly as in the Baseline Project, the flexibility built into the PDE would allow many other design capacity options that could have a relatively wide range of impacts. To summarize the range of potential configurations, this assessment of the Proposed Action describes four separate Project design capacity options (Table 3.11-9).

Table 3.11-9. Project Design Capacity Options

Option Name	Description
Baseline Project	Nameplate capacity of 712 MW and would use 89 8-MW WTGs*
Large WTG Baseline Project	Nameplate capacity of 720 MW and would use 60 12-MW WTGs
Large WTG Maximum Capacity Project	Capacity of 876 MW and would use 73 12-MW WTGs
Maximum Capacity Project	Capacity of 880 MW and would use 88 10-MW WTGs

Note: It is also technically possible that the Project could use 100 8-MW WTGs for a total capacity of 800 MW, but because this design capacity option does not provide as great of a generating capacity as other design capacity options using larger WTGs and is projected to have considerably higher capital costs per MW of power generated than the other design capacity options, it is not carried forward for further assessment.

* As discussed in the Demographics, Employment, and Economics section in Appendix G, Revolution Wind has indicated that they would install at least one additional WTG beyond the minimum number of WTGs required to meet the PPA (Roll 2021). Based on this information, a 712-MW project using 89 8-MW WTGs is the smallest project they would build. If they opted to use 10-MW WTGs, they would install at least 72 WTGs for a 720-MW project, even though they could technically meet the PPA with 71 10-MW WTGs. Similarly, if they used 12-MW WTGs, they would install 60 WTGs with a total capacity of 720 MW.

Table 3.11-10 shows the estimated employment, earnings, output, and value-added impacts of each the four design configurations. Most of the direct construction-related jobs generated by the Proposed Action would occur in the communities where the ports used for staging and fabrication are located. Most of the direct jobs would occur during engineering and construction of onshore and offshore wind energy facilities, whereas most of the indirect jobs would occur during wind energy component fabrication, storage, and transport. The induced jobs would occur as income generated from the direct and indirect jobs is spent throughout the local economy. Under the Proposed Action, construction is expected to occur within a 2-year period, but preconstruction activities such as design/engineering and component manufacturing and fabrication could lengthen the period an additional year. Where possible, local workers would be hired to meet labor needs for construction (see the discussion in Appendix G, as well as the EPMs Demo-1 through Demo–6 listed in Table F-1 in Appendix F).

Table 3.11-10. Estimated Jobs, Earnings, Output, and Value-Added in Rhode Island and Connecticut during Construction of the Proposed Action by Design Capacity Option

Design Capacity Option	Jobs	Earnings ($ millions)	Output ($ millions)	Value-Added ($ millions)
Baseline Project (712-MW capacity with 89 8-MW WTGs)				
Direct impacts	1,440	$124.40	$148.83	$130.10
Indirect impacts	1,623	$123.00	$497.43	$205.80
Induced impacts	793	$51.10	$137.63	$81.10
Total impacts	**3,856**	**$298.50**	**$783.90**	**$417.00**
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)				
Direct impacts	1,483	$121.13	$142.64	$128.36
Indirect impacts	1,789	$135.89	$563.62	$227.54
Induced impacts	827	$53.11	$142.83	$84.31
Total impacts	**4,100**	**$310.13**	**$849.08**	**$440.21**
Large WTG Maximum Capacity Project (876-MW capacity with 73 12-MW WTGs)				
Direct impacts	1,705	$134.78	$154.62	$141.63
Indirect impacts	2,265	$171.58	$738.27	$291.92
Induced impacts	1,006	$64.52	$173.36	$102.36
Total impacts	**4,976**	**$370.88**	**$1,066.25**	**$535.91**
Maximum Capacity Project (880-MW capacity with 88 10-MW WTGs)				
Direct impacts	1,706	$135.89	$157.60	$142.23
Indirect impacts	2,134	$161.84	$690.11	$275.84
Induced impacts	995	$64.02	$172.10	$101.56
Total impacts	**4,834**	**$361.75**	**$1,019.80**	**$519.63**

Source: Baseline Project estimates are from Hamilton and Nubbe (2020). Estimates for the Large WTG Baseline Project, the Maximum Capacity Project, and the Large WTG Maximum Capacity Project were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates are for the entire construction period. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours). Earnings are estimated incomes earned from the jobs. Output is the estimated values of all goods and services sold during construction. Value-added is the estimated change in GDP resulting from the change in output.

As shown in Table 3.11-10, the Large WTG Maximum Capacity Project is the design configuration expected to have the greatest beneficial impacts in terms of employment, earnings, output, and value-added. It would generate an estimated 4,976 FTE jobs during the 3-year preconstruction/construction period, with most of these jobs occurring in Rhode Island and Connecticut.

If the estimated increase in employment resulting from the Large WTG Maximum Capacity Project was evenly spread over the 3-year construction period, the annual FTE jobs created would be approximately 1,659, or less than 0.1% of the total labor force in Rhode Island and Connecticut in 2020 (see Table 3.11-4). Therefore, the employment impacts of the Proposed Action under the Large WTG Maximum Capacity Project configuration would be short term **minor** beneficial.

Table 3.11-10 also shows that over the preconstruction/construction period, the Large WTG Maximum Capacity Project is expected to generate nearly $536 million in value-added production to the combined GDP of Rhode Island and Connecticut. If this impact is realized in a single year, the value-added amount would represent 0.16% of the annual GDP for Rhode Island and Connecticut combined (see Table 3.11-3). Therefore, the economic activity impacts of the Proposed Action under the Large WTG Maximum Capacity Project configuration would be short term **minor** beneficial.

Revolution Wind has stated that the Project would be constructed under local Project Labor Agreements, and that offshore construction would be governed by the National Offshore Wind Agreement (VHB 2023).

In communities with ports used for staging and fabrication, construction activities could temporarily compete with the local commercial fishing industry for marine workers. As described in Section 3.9.2.2.1, some commercial fisheries in the New England and Mid-Atlantic regions face workforce challenges, with a lack of young people entering the industry. The competition for marine workers during Project construction could also result in higher prices for certain local shoreside support services. With an increase in service prices, some businesses in the commercial fishing industry and other marine sectors could seek services in ports not supporting Project construction.

The increased employment opportunities created during construction could result in population increases in those communities with ports used for staging and fabrication. In turn, these population increases could reduce local housing availability and strain existing public infrastructure and services. However, although some non-local workers could need temporary housing depending on the ports selected, it is expected that most of the workers involved in the installation of offshore facilities would be housed onboard vessels and would be expected to work for several weeks at sea before returning to shore. These conditions suggest that offshore construction crews would have little incentive to relocate to a port community. In addition, local hiring practices by Revolution Wind contractors would mitigate population increases. Therefore, construction would have a short-term **negligible** adverse impact on demographic-related variables such as housing availability and demand for public infrastructure and services for all design configurations analyzed under the Proposed Action.

Offshore Activities and Facilities

<u>Light</u>: During construction and installation, adverse impacts on businesses dependent on tourism would be the same as the No Action Alternative (see Section 3.11.2.2.3) (i.e., localized and short term **negligible** to **moderate** adverse) based on the observed distance and individual responses by tourists to changes in the viewshed for all design configurations analyzed under the Proposed Action.

<u>New cable emplacement/maintenance</u>: As described in Section 3.9, some individual operators of commercial fishing or for-hire recreational fishing businesses could experience adverse economic impacts during construction of the offshore transmission cable and IACs. The impacts of new cable emplacement/maintenance to demographic, employment, and economic conditions in the GAA would be

the same as the No Action Alternative (see Section 3.11.2.2.3) and as the presence of structures impact rating: short term **minor** to **moderate** adverse for all design configurations analyzed under the Proposed Action.

Presence of structures: As described in Section 3.9, some individual operators of commercial fishing or for-hire recreational fishing businesses could experience adverse economic impacts during construction of WTGs and OSSs. However, only a small number of commercial fishing vessels depend heavily on harvests in the Lease Area for their fishing revenue, and many fishing vessel operators have the ability to adjust transit and fishing locations to avoid conflicts with construction activities. In addition, Revolution Wind's communication plans with the fishing industry and its financial compensation program for damage to or loss of fishing gear, as described in Orsted U.S. Offshore Wind (2020), would help ensure that fishing industry sectors, including harvesting operations, seafood processors and distributors, and shoreside support services, could continue to operate with minimal disruption. Therefore, impacts to employment and economic activity in the fishing industry would be short term **minor** to **moderate** adverse for all design configurations analyzed under the Proposed Action.

Vessel traffic: Vessel traffic related to Project construction would be the same as the No Action Alternative (see Section 3.11.2.2.3) and would represent a short-term **minor** to **moderate** adverse impact to demographic, employment, or economic conditions in the GAA for all design configurations analyzed under the Proposed Action.

Onshore Activities and Facilities

Port utilization: Port utilization activities during Project construction would be the same as the No Action Alternative (see Section 3.11.2.2.3). Therefore, port utilization impacts during offshore wind energy Project construction are expected to be localized and short term **minor** to **moderate** adverse for all design configurations analyzed under the Proposed Action.

Economic benefits could accrue to ports that undertake improvements to support the development of the Proposed Action. However, although selected ports could require upgrades to meet the construction needs of the Proposed Action (see Table 3.3.10-1 in VHB [2023]), no specific port improvements have been proposed as part of the Proposed Action.

Vehicular traffic: Most offshore components of the Proposed Action would be transported by sea. However, some materials and equipment would arrive by land at varying frequencies throughout the construction period. Vehicular traffic would include truck and automobile traffic over existing roads and highways proximate to the marshaling and/or logistics facilities in the ports(s) where Project staging, assembly, and fabrication occur. This additional traffic could result in temporary, localized traffic delays that impact nearby businesses. See Section 3.14 for additional details related to traffic impacts. However, the proposed ports currently experience fluxes in traffic volumes during normal operations, and Project-related traffic is expected to be well within these daily fluctuations in traffic. Moreover, maintenance and protection of traffic setups would be implemented to minimize impacts to traffic (see Table F-1 in Appendix F).

Construction of the onshore facilities of the Proposed Action could also result in temporary, localized traffic delays that impact nearby businesses (see Section 3.14). Revolution Wind will coordinate with local authorities during construction of onshore facilities to minimize local traffic impacts. In addition, the construction schedule would be designed to minimize impacts to the local community during the summer tourist season, generally between Memorial Day and Labor Day (see Table F-1 in Appendix F). On this basis, the overall effects of vehicular traffic on demographics, employment, and economics during construction of offshore and onshore facilities would be short term **negligible** to **minor** adverse for all design configurations analyzed under the Proposed Action.

3.11.2.3.2 Operations and Maintenance and Decommissioning

Employment and Economic Activity Impacts of Operations and Maintenance and Decommissioning

Table 3.11-11 shows estimated employment, earnings, output, and value-added impacts during O&M of the Proposed Action for the four design configurations described above. The JEDI-OWM assumes that impacts of O&M activities are directly proportional to nameplate capacity regardless of the number of WTGs. The O&M impacts presented in Table 3.11-11 would occur annually over the expected 35-year life of the Project. The Port of Davisville at Quonset Point, Port Jefferson, Port of Brooklyn, and Port of Montauk have been identified as possible ports supporting O&M of the Proposed Action (VHB 2023). Where possible, local workers would be hired to meet labor needs for O&M (see Table F-1 in Appendix F).

Table 3.11-11. Estimated Jobs, Earnings, Output, and Value-Added during Operations and Maintenance of the Proposed Action by Design Capacity Option

Design Capacity Option	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Baseline Project (712-MW capacity with 89 8-MW WTGs)	233	$17.20	$85.70	$70.00
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	236	$17.39	$86.66	$70.79
Large WTG Maximum Capacity Project (876-MW capacity with 73 12-MW WTGs)	287	$21.16	$105.44	$86.12
Maximum Capacity Project (880-MW capacity with 88 10-MW WTGs)	288	$21.26	$105.92	$86.52

Source: Baseline Project estimates are from Hamilton and Nubbe (2020). Estimates for the Large WTG Baseline Project, the Maximum Capacity Project, and the Large WTG Maximum Capacity Project were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates would occur annually over the 35-year life of the Project. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours).

As shown in Table 3.11-11, the Large WTG Maximum Capacity Project is expected to generate a total of 287 FTE jobs annually. If this increase in employment completely occurred in Washington County, Rhode Island, it would represent 0.45% of the total employment in the county in 2020 (see Table 3.11-4). Similarly, if all of the O&M jobs are located in Suffolk County, New York, they would represent 0.04% of employed persons in the county in 2020 (see Table 3.11-4). Therefore, the employment impacts of the Proposed Action under the Large WTG Maximum Capacity Project configuration would be long term **minor** beneficial.

Decommissioning of the Project's offshore facilities is estimated to take 2 years to complete. BOEM estimates that decommissioning costs would be approximately half of the Project construction costs (AECOM 2017), with economic impacts (jobs and income) estimated to be approximately 50% of those shown in Table 3.11-11. Because labor and contracting would account for a substantial portion of decommissioning costs, a relatively high percentage of decommissioning expenditures are expected to accrue to local economies. Therefore, decommissioning would have a short-term **minor** beneficial impact to demographic, employment, or economic conditions in the GAA for all design configurations analyzed under the Proposed Action. There would be no further demographic, employment, and economic impacts once decommissioning is complete.

Offshore Activities and Facilities

Light: To the extent that lighting for offshore Project facilities decreases tourist visitation rates, employment and economic activity in service industries that support tourism would be adversely affected. However, Revolution Wind has committed to implement ADLS as an EPM to reduce light impacts (see Table F-1 in Appendix F) and visual impacts on recreation and tourism during O&M. Therefore, the adverse impacts of light to demographic, employment, or economic conditions in the GAA are expected to be long term but **negligible** for all design configurations analyzed under the Proposed Action.

New cable emplacement/maintenance: The impacts of new cable emplacement and maintenance to demographic, employment, and economic conditions in the GAA would be the same as the No Action Alternative (see Section 3.11.2.2.3) and as the presence of structures impact rating: short term **minor** to **moderate** adverse for all design configurations analyzed under the Proposed Action.

Presence of structures: As described in Section 3.9, some individual operators of commercial fishing or for-hire recreational fishing businesses could experience adverse economic impacts during O&M as a result of the presence of WTGs and OSSs. However, only a small number of commercial fishing vessels depend heavily on harvests in the Lease Area for their fishing revenue, and many fishing vessel operators have the ability to adjust transit and fishing locations to avoid conflicts with Project offshore facilities and activities. In addition, WTG spacing and orientation measures and offshore cable burial, together with Revolution Wind's communication plans with the fishing industry and its financial compensation program for damage to or loss of fishing gear (Orsted U.S. Offshore Wind 2020), would help ensure that fishing industry sectors, including harvesting operations, seafood processors and distributors, and shoreside support services, could continue to operate with minimal disruption. Therefore, adverse impacts to employment and economic activity in the fishing industry would be long term **minor** to **moderate** for all design configurations analyzed under the Proposed Action.

Vessel traffic: In comparison to the construction phase, Project O&M would require a reduced number of vessels, and most of the vessels would be smaller in size (VHB 2023). Although the number of vessel transits would increase during O&M relative to construction, O&M vessel traffic would not have the same influx of a large number of vessels during a compressed time period seen during construction (see Section 3.16). Therefore, the impacts of vessel traffic to demographic, employment, or economic conditions in the GAA would be long term **minor** adverse for all design configurations analyzed under the Proposed Action.

Onshore Activities and Facilities

Port utilization: During Project O&M, port facilities would be required for vessels used for routine maintenance of offshore Project components. These vessels would require berthing and would add traffic to port facilities. However, in comparison to the construction phase, Project O&M would require a reduced number of vessels (VHB 2023) (see Section 3.16). Given the relatively low number of vessels, the impacts on the accessibility of port facilities would be long term **minor** adverse for all design configurations analyzed under the Proposed Action.

Vehicular traffic: Vehicular traffic impacts associated with O&M of the onshore and offshore facilities of the Proposed Action would be the same as the No Action Alternative (see Section 3.11.1.1.2) and would be long term **negligible** to **minor** adverse for all design configurations analyzed under the Proposed Action.

3.11.2.3.3 Cumulative Impacts

Employment and Economic Activity Impacts of Combined Offshore Wind Energy Projects

BOEM currently estimates that nearly 46 GW of offshore wind farm capacity on the Atlantic Seaboard would be installed and operational by the end of 2030, including Revolution Wind. This offshore wind energy development would create a demand for workers skilled in the professions and trades needed for the design, construction, and O&M of offshore wind energy facilities. Construction activities related to future offshore wind energy projects are expected to generate an average of 29,389 FTE job-years from 2022 to 2030, including direct, indirect, and induced jobs. If the Maximum Capacity Project is installed (with a total of 4,976 FTE jobs) under the Proposed Action, it would add an additional 1.9% to the average. By 2031, O&M activities related to future offshore wind projects are expected to support nearly 21,598 annual FTE jobs if direct, indirect, and induced jobs are included, with the Maximum Capacity Project under the Proposed Action accounting for approximately 1.1% of those O&M jobs. Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the Project would have long-term **minor** beneficial impacts for demographics, employment, and economics.

Offshore Activities and Facilities

Light: The view of nighttime lighting during construction and operations of offshore wind energy structures, including the Proposed Action, could have impacts on employment and economic activity in the tourism industry by affecting the decisions of tourists in selecting coastal locations to visit (see Section 3.18). Adverse impacts on businesses dependent on tourism would be localized and short term during construction and long term during operations, with **negligible** to **moderate** adverse impacts based on the observed distance and individual responses by tourists to changes in the viewshed. If ADLS (or a similar system) is installed on WTGs (as it would be for the Project), impacts to demographic, employment, or economic conditions in the GAA would be reduced to **negligible** to **minor** adverse for all design configurations analyzed under the Proposed Action because the amount of time WTGs would be visible at night would decrease (see Section 3.20).

New cable emplacement/maintenance: The impacts of new cable emplacement and maintenance to demographic, employment, and economic conditions in the GAA would be the same as the No Action Alternative (see Section 3.11.2.2.3) and as the presence of structures impact rating: short term adverse during construction/decommissioning and long term during operations, and **minor** to **moderate** adverse for all design configurations analyzed under the Proposed Action.

Presence of structures: The Proposed Action in addition to other current and future offshore wind energy development would result in the installation of an estimated 13,716 miles of offshore export cables and IACs and 3,190 offshore foundations.[38] The Proposed Action would account for 1.8% of the additional offshore cables and IAC and 3% of the additional offshore foundations. An analysis of the impacts of offshore wind energy structures, including WTGs and offshore submarine cables, to commercial fisheries and for-hire recreational fishing that could result from future offshore wind energy development is provided in Section 3.9. To the extent that the impacts of future offshore wind activities, including the Proposed Action, result in declines in the economic performance of commercial and for-hire recreational fisheries, workers employed in these fisheries, including fishing vessel crewmembers and seafood processor workers, could be adversely affected. However, WTG spacing and orientation measures, offshore cable burial, financial compensation programs for fishing interests, and other mitigation measures implemented by offshore wind developers, together with the ability of fishing vessel operators to adjust transit and fishing locations to avoid conflicts with construction related to offshore wind energy development, would help ensure that fishing businesses could continue to operate with minimal disruption. Therefore, economic impacts to commercial fisheries and for-hire recreational fishing would be short term **minor** to **moderate** adverse during construction/decommissioning and long term **minor** to **moderate** adverse during operations for all design configurations analyzed under the Proposed Action.

Vessel traffic: Vessel traffic related to construction and installation, O&M, and decommissioning of offshore wind energy projects, including the Proposed Action, could cause congestion and delays, thereby increasing vessel fuel costs (i.e., for vessels forced to wait for port traffic to pass) and decreasing productivity for commercial shipping businesses (see Section 3.16). In addition, the risk of collisions that result in costly vessel damage and loss could increase. However, in comparison to the construction phases of projects, a reduced number of vessels would likely be required for routine maintenance during the operations phase. Therefore, the impacts of vessel traffic to demographic, employment, or economic conditions in the GAA for all design configurations analyzed under the Proposed Action would be short term **minor** to **moderate** adverse during construction/decommissioning and long term and **negligible** to **minor** adverse during operations.

Onshore Activities and Facilities

Port utilization: Offshore wind energy projects, including the Proposed Action, would involve port utilization activities as described under the No Action Alternative (see Section 3.11.2.2.3). Therefore, port utilization impacts for all design configurations analyzed under the Proposed Action are expected to be localized, and short term **minor** to **moderate** adverse during construction and decommissioning and long term **minor** adverse during operations.

Offshore wind energy projects could generate employment opportunities and economic activity at ports used to support O&M of projects through port upgrades and development, as well as marine transportation. Additional shore-based and marine workers would be hired, resulting in a trained workforce for the offshore wind energy industry. Moreover, port improvements would support and

[38] Based on planned future Atlantic OCS wind projects as described in Table E3-1 (parts 2–4) in Appendix E3.

enhance other port activities. Although selected ports could require upgrades to meet the construction needs of the Proposed Action, no specific port improvements have been proposed as part of the Proposed Action. Therefore, the economic benefits of the Proposed Action are uncertain. Overall, however, the port investment and usage generated by offshore wind energy development would have long-term **minor** to **moderate** beneficial impacts to demographic, employment, or economic conditions in the GAA.

<u>Vehicular traffic</u>: Actions associated with construction and installation, O&M, and decommissioning of the onshore and offshore facilities of offshore wind energy projects, including the Proposed Action, could result in localized traffic delays along impacted roads (see Section 3.14). These traffic delays could temporarily restrict access to adjacent commercial properties. State and local agencies would be responsible for managing actions to help minimize and avoid traffic delays and other impacts on nearby businesses. On this basis, the effects of the additional vehicular traffic to demographic, employment, or economic conditions in the GAA would be short term **negligible** to **minor** adverse during construction and decommissioning, and long term **negligible** to **minor** adverse during operations for all design configurations analyzed under the Proposed Action.

3.11.2.3.4 Conclusions

Although employment and economic activity related to Project construction would have **minor** beneficial impacts, many of the other IPFs are likely to have **negligible** to **moderate** adverse impacts. Therefore, BOEM is unable to make a single overall impact determination with respect to demographics, employment, and economics conditions.

As a result of the employment and economic activity supported by Project construction, O&M, and decommissioning, BOEM expects the Proposed Action to have an overall long-term **minor** beneficial impact on demographic, employment, and economic conditions in the GAA for all design configurations analyzed under the Proposed Action.

Considering all the IPFs together, BOEM anticipates that the overall adverse impacts of future offshore wind energy development, including the Proposed Action, on demographic, employment, and economic conditions in the GAA would be short term during construction, long term during O&M, and **moderate**. This rating primarily reflects adverse impacts to employment and economic activity in commercial fisheries.

Ongoing and future non–offshore wind energy activities would have long-term **major** adverse impacts on demographic, employment, and economic conditions in the GAA as a result of climate change and the associated risks of flooding, extreme heat, and storm damage. Ongoing and future non–offshore wind energy activities would also have long-term **moderate** beneficial impacts on some local economies, driven primarily by the ongoing operations of existing marine industries in parts of the GAA, especially recreation/tourism, and shipping.

BOEM anticipates that the adverse impacts associated with future offshore wind activities in the GAA combined with ongoing and reasonably foreseeable activities other than offshore wind would be long term **major** as a result of climate change. These major adverse impacts from climate change are driven by cumulative activities and trends and not by emissions from the Project. Long-term **moderate** beneficial impacts would occur in some local economies, representing notable and measurable improvements in employment and income as a result of ongoing economic development.

3.11.2.4 Alternatives C, D, E, and F

Table 3.11-5 provides a summary of IPF findings for these alternatives.

3.11.2.4.1 Construction and Installation

Employment and Economic Activity Impacts of Construction and Installation

Tables 3-11.12 through 3.11-15 show estimated total employment, total earnings, total output, and total value-added impacts during construction under Alternatives C through F for the range of feasible design configurations. As with the Proposed Action, the exact locations of these economic impacts cannot be determined because the final set of ports has not been specified.

The higher-end projections of employment and economic activity during construction under Alternative C are smaller than the higher-end projections under the Proposed Action. However, the lower-end and higher-end estimates of the economic impacts of Alternative D across design configurations are not markedly different from those for the Proposed Action. Feasible projects under Alternative E and F also result in similar levels of economic impacts as are expected under the Proposed Action. Therefore, the impacts of Alternatives C through F to demographic, employment, or economic conditions in the GAA would be similar to the Proposed Action: short term **minor** beneficial for all design configurations analyzed.

Table 3.11-12. Estimated Jobs, Earnings, Output, and Value-Added in Rhode Island and Connecticut during Construction under Alternative C by Design Capacity Option

Design Capacity Option	Alternative for which the Design Capacity Option is Applicable	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	C1 and C2	4,100	$310.13	$849.08	$440.21
780-MW Project with 65 12-MW WTGs	C1	4,330	$325.90	$899.10	$463.10
768-MW Project with 64 12-MW WTGs	C2	4,231	$317.44	$882.97	$452.15

Source: Estimates were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates are for the entire construction period. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours). Earnings are estimated incomes earned from the jobs. Output is the estimated values of all goods and services sold during construction. Value-added is the estimated change in GDP resulting from the change in output.

The assessment of Alternative C builds of the Project configurations described for the Proposed Action in Section 3.11.2.2.1. If no more than 65 WTGs are allowed under Alternative C1, the Large WTG Baseline Project (720 MW with 60 12-MW WTGs) from the Proposed Action could be installed while still meeting the PPA under Alternative C1. However, none of the other three design configurations described in the Proposed Action could be installed. The largest design configuration possible under Alternative C1 would be a 780-MW project with 65 12-MW WTGs. The largest design configuration possible under Alternative C2 would be a 768-MW project with 64 12-MW WTGs.

Table 3.11-13. Estimated Jobs, Earnings, Output, and Value-Added in Rhode Island and Connecticut during Construction under the Alternative D by Design Capacity Option

Design Capacity Option	Alternatives to which the Design Capacity Option is Applicable	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Baseline Project (712-MW capacity with 89 8-MW WTGs)	D1, D2, or D3	3,856	$298.50	$783.90	$417.00
Midsize WTG Baseline Project (720-MW capacity with 72 10-MW WTGs)	D1, D2, D3, D1+D2, D1+D3, D2+D3, or D1+D2+D3	3,918	$297.25	$801.90	$419.82
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	D1, D2, D3, D1+D2, D1+D3, D2+D3, or D1+D2+D3	4,100	$310.13	$849.08	$440.21
Large WTG Maximum Capacity Project (876-MW capacity with 73 12-MW WTGs)	D1, D2, D3, D1+D2, D1+D3, D2+D3, or D1+D2+D3	4,976	$370.88	$1,066.25	$535.91
Maximum Capacity Project (880-MW capacity with 88 10-MW WTGs)	D1, D2, or D3	4,834	$361.75	$1,019.80	$519.63

Source: Baseline Project estimates are from Hamilton and Nubbe (2020). Estimates for the other listed projects were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates are for the entire construction period. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours). Earnings are estimated incomes earned from the jobs. Output is the estimated values of all goods and services sold during construction. Value-added is the estimated change in GDP resulting from the change in output.

If Alternative D1+D2, Alternative D1+D3, or Alternative D2+D3 are selected, then the Midsize WTG Baseline Project (720-MW project with 72 10-MW WTGs) or the Large WTG Baseline Project (introduced in Section 3.11.2.2.1) could be installed if Revolution Wind's goal is to minimally meet the current PPA requirements. If Revolution Wind wishes to maximize its total capacity, then the Large WTG Maximum Capacity Project described in Section 3.11.2.2.1 would be feasible.

If Alternative D1+D2+D3 is selected, then no more than 80 WTGs could be installed. In this case, the Midsize WTG Baseline Project (720-MW project with 72 10-MW WTGs) or the Large WTG Baseline Project could be installed to meet the minimum PPA, whereas the Large WTG Maximum Capacity Project would be feasible if Revolution Wind maximizes total Project capacity.

Table 3.11-14. Estimated Jobs, Earnings, Output, and Value-Added in Rhode Island and Connecticut during Construction under the Alternative E by Design Capacity Option

Design Capacity Option	Alternatives to which the Design Capacity Option is Applicable	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	E1 and E2	4,100	$310.13	$849.08	$440.21
Midsize WTG Baseline Project (720-MW capacity with 72 10-MW WTGs)	E2	3,918	$297.25	$801.90	$419.82
64-WTG Maximum Capacity Project (768-MW capacity with 64 12-MW WTGs)	E1 and E2	4,231	$317.44	$882.97	$452.15
Large WTG Maximum Capacity Project (876-MW capacity with 73 12-MW WTGs)	E2	4,976	$370.88	$1,066.25	$535.91

Source: Estimates were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates are for the entire construction period. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours). Earnings are estimated incomes earned from the jobs. Output is the estimated values of all goods and services sold during construction. Value-added is the estimated change in GDP resulting from the change in output.

Under Alternative E1, there are only five feasible configurations, all of which would use 12-MW WTGs. The 704-MW PPA can be met with the Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs), which was introduced with the Proposed Action. The largest capacity project that could be built is a 64-WTG Maximum Capacity Project (768 MW with 64 12-MW WTGs), which was also discussed with respect to Alternative C2 in Section 3.11.2.3.1. It would also be possible to build three smaller projects using 61, 62, or 63 WTGs each with a 12-MW capacity.

It is clear that all of the design capacity options available for Alternative E1 are also feasible under Alternative E2. Alternative E2 allows up to eight more WTGs, which would allow the Large WTG Maximum Capacity Project (876-MW project capacity with 73 12-MW WTGs), which was initially introduced in Section 3.11.2.2.1 with the Proposed Action. Also feasible under Alternative E1 are two project configurations that use 10-MW WTGs: a 72-WTG project that meets the PPA with a total capacity of 720 MW and a 730-MW project that uses one additional 10-MW WTG.

Table 3.11-15. Estimated Jobs, Earnings, Output, and Value-Added in Rhode Island and Connecticut during Construction under the Alternative F by Design Capacity Option

Design Capacity Option	Alternatives to which the Design Capacity Option is Applicable	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Very Large WTG Baseline Project (728-MW capacity with 52 14-MW WTGs)	Feasible under all alternatives	4,295	$320.62	$916.04	$461.31
Very Large WTG Maximum Capacity Project (868-MW capacity with 62 14-MW WTGs)	Feasible under all alternatives	5,212	$384.88	$1,140.90	$562.30

Source: Estimates were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates are for the entire construction period. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours). Earnings are estimated incomes earned from the jobs. Output is the estimated values of all goods and services sold during construction. Value-added is the estimated change in GDP resulting from the change in output.

Under Alternative F, the largest allowable WTGs would increase from 12 to 14 MW. Therefore, based on information from Roll (2021), the minimum capacity that would be installed to meet the 704-MW PPA would have a total nameplate capacity of 728 MW and would use 52 14-MW WTGs. The largest project that could be installed (within the PDE maximum Project capacity of 880 MW) would be an 868-MW project that uses 62 14-MW WTGs.

Both of these Project configurations would be feasible under the Proposed Action and any of the other alternatives that constrain the number of WTGs that would be allowed (Alternatives C–E).

3.11.2.4.2 Operations and Maintenance and Decommissioning

Employment and Economic Activity Impacts of Operations and Maintenance and Decommissioning

Tables 3.11-16 through 3.11-19 show estimated employment, earnings, output, and value-added impacts during O&M under Alternatives C through F for the design configurations that are feasible. The tables show total economic impacts, including direct, indirect, and induced impacts.

The higher-end projections of employment and economic activity during O&M under Alternative C are smaller than the higher-end projections under the Proposed Action. The lower-end and higher-end estimates of the economic impacts of Alternative D and across design configurations and Alternative F are not markedly different from those for the Proposed Action. Likewise, all of the design configurations under Alternative E fall within the range of design configurations for the Proposed Action. Therefore, the impacts of Alternatives C through F to demographic, employment, or economic conditions in the GAA would be similar to the Proposed Action: short term **minor** beneficial for all design configurations analyzed.

Decommissioning under Alternatives C through F would likely have a smaller impact than the Proposed Action, with economic impacts (jobs and income) estimated to be approximately 50% of those shown in Tables 3.11-12 through 3.11-15. These impacts would not differ markedly from the Proposed Action. Decommissioning would have a short-term **minor** beneficial impact to demographic, employment, or economic conditions in the GAA. There would be no further demographic, employment, and economic impacts once decommissioning is complete.

Table 3.11-16. Estimated Jobs, Earnings, Output, and Value-Added during Operations and Maintenance under Alternative C by Design Capacity Option

Design Capacity Option	Alternative for which the Design Capacity Option is Applicable	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	C1 and C2	236	$17.39	$86.66	$70.79
780-MW Project with 65 12-MW WTGs	C1	255	$18.84	$93.88	$76.69
768-MW Project with 64 12-MW WTGs	C2	251	$18.55	$92.44	$75.51

Source: Estimates were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates would occur annually over the 35-year life of the Project. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours).

Table 3.11-17. Estimated Jobs, Earnings, Output, and Value-Added during Operations and Maintenance under the Alternative D by Design Capacity Option

Design Capacity Option	Alternatives to which the Design Capacity Option is Applicable	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Baseline Project (712-MW capacity with 89 8-MW WTGs)	D1, D2, or D3;	233	$17.20	$85.70	$70.00
Midsize WTG Baseline Project (720-MW capacity with 72 10-MW WTGs)	D1, D2, D3, D1+D2, D1+D3, D2+D3, or D1+D2+D3	236	$17.39	$86.66	$70.79
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	D1, D2, D3, D1+D2, D1+D3, D2+D3, or D1+D2+D3	236	$17.39	$86.66	$70.79
Large WTG Maximum Capacity Project (876-MW capacity with 73 12-MW WTGs)	D1, D2, D3, D1+D2, D1+D3, D2+D3, or D1+D2+D3	287	$21.16	$105.44	$86.12
Maximum Capacity Project (880-MW capacity with 88 10-MW WTGs)	D1, D2, or D3	288	$21.26	$105.92	$86.52

Source: Baseline Project estimates are from Hamilton and Nubbe (2020). Estimates for the other listed projects were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates would occur annually over the 35-year life of the Project. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours).

Table 3.11-18. Estimated Jobs, Earnings, Output, and Value-Added during Operations and Maintenance under the Alternative E by Design Capacity Option

Design Capacity Option	Alternatives to which the Design Capacity Option is Applicable	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	E1 and E2	236	$17.39	$86.66	$70.79
Midsize WTG Baseline Project (720-MW capacity with 72 10-MW WTGs)	E2	236	$17.39	$86.66	$70.79
64-WTG Maximum Capacity Project (768-MW capacity with 64 12-MW WTGs)	E1 and E2	251	$18.55	$92.44	$75.51
Large WTG Maximum Capacity Project (876-MW capacity with 73 12-MW WTGs)	E2	287	$21.16	$105.44	$86.12

Source: Estimates were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates would occur annually over the 35-year life of the Project. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours).

Table 3.11-19. Estimated Jobs, Earnings, Output, and Value-Added during Operations and Maintenance under the Alternative F by Design Capacity Option

Design Capacity Option	Alternatives to which the Design Capacity Option is Applicable	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Very Large WTG Baseline Project (728-MW capacity with 52 14-MW WTGs)	Feasible under all alternatives	238	$17.59	$87.63	$71.57
Very Large WTG Maximum Capacity Project (868-MW capacity with 62 14-MW WTGs)	Feasible under all alternatives	284	$20.97	$104.48	$85.34

Source: Estimates were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates would occur annually over the 35-year life of the Project. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours).

3.11.2.4.3 Cumulative Impacts

Employment and Economic Activity Impacts of Combined Offshore Wind Energy Projects

Under Alternatives C through F, BOEM estimates that nearly 46 GW of offshore wind farm capacity could be installed and operational by the end of 2030. This offshore wind energy development would create a demand for workers skilled in the professions and trades needed for the design, construction, and O&M of offshore wind energy facilities. Construction activities related to future offshore wind energy projects are expected to generate an average of 29,800 FTE job-years from 2022 through 2030, including direct, indirect, and induced jobs. By 2031, there would be an annual average of 21,850 O&M jobs with the Project under these alternatives.

If the highest feasible capacity configurations under Alternative C1 or Alternative C2 are installed, the Project would account for approximately 1.6% of all offshore wind construction job-years from 2022 to 2030 and 1.1% to 1.2% of O&M jobs in 2031.

Under Alternative D, Project construction jobs are expected to range from 1.4% to 1.8% of the annual average of all offshore wind construction jobs from 2022 to 2030, and Project O&M jobs are expected to range from 1.1% to 1.3% of O&M activities related to future offshore wind projects in 2031.

Under Alternative E, Project construction jobs are expected to range from 1.5% to 1.6% of the annual average of all offshore wind construction jobs from 2022 to 2030, and Project O&M jobs are expected to range from 1.1% to 1.3% of O&M activities related to future offshore wind projects in 2031.

Under Alternative F, Project construction jobs are expected to range from 1.6% to 1.9% of all offshore wind energy construction jobs from 2022 to 2030, and Project O&M jobs are expected to range from 1.1% to 1.3% of O&M activities related to future offshore wind projects in 2031.

Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the Project would have long-term **minor** beneficial impacts from construction and O&M jobs and economic activity.

3.11.2.4.4 Conclusions

When compared to the maximum case under the Proposed Action, Alternatives C through F under all layout options could reduce the number of WTGs, which would have an associated reduction in job and income losses due to disruption of commercial fisheries or for-hire recreational fishing and a reduction in adverse visual impacts on the tourism industry. However, BOEM expects that the overall level of impacts to demographic, employment, and economic conditions in the GAA resulting from Alternatives C through F alone would be similar to the Proposed Action: long-term **minor** beneficial for all Project design configurations analyzed as a result of the employment and economic activity supported by Project construction and installation, O&M, and decommissioning.

In the context of other reasonably foreseeable environmental trends and planned actions, BOEM expects that Alternatives C through F’s impacts to demographic, employment, and economic conditions in the GAA would be similar to the Proposed Action. Therefore, the overall impacts of Alternatives C through F when combined with past, present, and reasonably foreseeable activities would be the same as the Proposed Action: long term **major** adverse as a result of climate change. These major adverse impacts from climate change are driven by cumulative activities and trends and not by emissions from the Project. Beneficial impacts would be long term **moderate**, representing notable and measurable improvements in some local economies in the GAA.

3.11.2.5 Alternative G: Impacts of the Preferred Alternative on Demographics, Employment, and Economics

Under Alternative G, there is only one design configuration among the modeled scenarios that 1) falls within the constraints of the alternative (i.e., no more than 65 installed WTGs); 2) complies with the PDE (i.e., uses WTGs of 8- to 12-MW capacity); and 3) complies with information supplied by Revolution Wind (Roll 2021)—specifically that all WTGs used must have the same capacity, and that the Project, as built, would use at least one additional WTG beyond the number needed to meet the 704-MW total capacity required by the PPA. If 12-MW WTGs are used, then 59 WTGs is the minimum number of WTGs to meet the PPA (59 WTGs × 12 MW = 708 MW). Adding one additional WTG beyond the PPA minimum would boost the total to 60 WTGs. This configuration is consistent with the Large WTG Baseline Project described and assessed under Alternatives B, C, D, and E. Although the use of 11-MW WTGs was not specifically modeled due to the limitations of the model variables, the economic impacts of using 11-MW WTGs would likely be close to the impacts of the Large WTG Baseline Project. This is because using 11-MW WTGs would only entail a slight decrease in the WTG size and a slight increase in the number of WTGs, and the effects of these slight changes on economic impact levels would largely offset each other.

3.11.2.5.1 Construction and Installation

Employment and Economic Activity Impacts of Construction and Installation

Table 3.11-20 shows the estimated total employment, total earnings, total output, and total value-added impacts during construction under Alternative G. As with the Proposed Action, the exact locations of these economic impacts cannot be determined because the final set of ports has not been specified. Therefore, the impacts of Alternative G to demographic, employment, or economic conditions in the GAA would be similar to the Proposed Action: short term **minor** beneficial for all design configurations analyzed.

Table 3.11-20. Estimated Jobs, Earnings, Output, and Value-Added in Rhode Island and Connecticut during Construction Alternative G

Design Capacity Option	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	4,100	$310.13	$849.08	$440.21

Source: Estimates were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates are for the entire construction period. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours). Earnings are estimated incomes earned from the jobs. Output is the estimated value of all goods and services sold during construction. Value-added is the estimated change in GDP resulting from the change in output.

The assessment of Alternative G builds of the Project configurations described for the Proposed Action in Section 3.11.2.2.1.

3.11.2.5.2 Operations and Maintenance and Decommissioning

Employment and Economic Activity Impacts of Operations and Maintenance and Decommissioning

Table 3.11-21 shows estimated employment, earnings, output, and value-added impacts during O&M under Alternative G for the single design configuration that is feasible. Projections of employment and economic activity during O&M are smaller than the higher-end projections under the Proposed Action and consistent with the lower-end estimates of economic impacts. Therefore, the impacts under O&M of Alternative G to demographic, employment, or economic conditions in the GAA would be similar to the Proposed Action: short term **minor** beneficial for all design configurations analyzed.

Decommissioning under Alternative G would likely have a smaller impact than the Proposed Action, with economic impacts (jobs and income) estimated to be approximately 50% of those shown in Table 3.11-20. These impacts would not differ markedly from the Proposed Action. Decommissioning would have a short-term **minor** beneficial impact to demographic, employment, or economic conditions in the GAA. There would be no further demographic, employment, and economic impacts once decommissioning is complete.

Table 3.11-21. Estimated Jobs, Earnings, Output, and Value-Added during Operations and Maintenance under Alternative G

Design Capacity Option	Total Jobs	Total Earnings ($ millions)	Total Output ($ millions)	Total Value-Added ($ millions)
Large WTG Baseline Project (720-MW capacity with 60 12-MW WTGs)	**236**	**$17.39**	**$86.66**	**$70.79**

Source: Estimates were developed using information and models in Hamilton and Nubbe (2020) and in NREL (2017, 2021).

Note: Employment, earnings, output, and value-added estimates would occur annually over the 35-year life of the Project. Jobs are reported in terms of FTEs, with one FTE equal to one person working full time for 1 year (2,080 hours).

3.11.2.5.3 Cumulative Impacts

Employment and Economic Activity Impacts of Combined Offshore Wind Energy Projects

Under Alternative G, BOEM estimates that nearly 46 GW of offshore wind farm capacity could be installed and operational by the end of 2030. This offshore wind energy development would create a demand for workers skilled in the professions and trades needed for the design, construction, and O&M of offshore wind energy facilities. Construction activities related to future offshore wind energy projects are expected to generate an average of 29,800 FTE job-years from 2022 to 2030, including direct, indirect, and induced jobs. Annual jobs related to O&M (including direct, indirect and induced jobs) are expected to reach 21,850 in 2031 after all of the planned projects are presumed to be operational.

If Alternative G is installed as described above, the Project would account for approximately 1.5% of the construction related job-years from 2022 to 2030. Alternative G is expected to generate a total of 236 O&M jobs annually once the Project begins operations or 1.1% of all O&M jobs in the offshore wind energy sector in 2031.

Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the Project would have long-term **minor** beneficial impacts for demographics, employment, and economics.

3.11.2.5.4 Conclusions

When compared to the maximum case under the Proposed Action, Alternative G would reduce the number of WTGs, which would have an associated reduction in job and income losses due to disruption of commercial fisheries or for-hire recreational fishing, and a reduction in adverse visual impacts on the tourism industry. However, BOEM expects that the overall level of impacts to demographic, employment, and economic conditions in the GAA would be similar to the Proposed Action: long term **minor** beneficial as a result of the employment and economic activity supported by Project construction and installation, O&M, and decommissioning.

In the context of other reasonably foreseeable environmental trends and planned actions, BOEM expects that Alternative G's impacts to demographic, employment, and economic conditions in the GAA would be similar to the Proposed Action. Therefore, the overall impacts of Alternative G when combined with past, present, and reasonably foreseeable activities would be the same as under the Proposed Action: long term **major** adverse as a result of climate change. These major adverse impacts from climate change are driven by cumulative activities and trends and not by emissions from the Project. Beneficial impacts would be long term **moderate**, representing notable and measurable improvements in some local economies in the GAA.

3.11.2.6 Mitigation

There are no potential additional mitigation measures for demographics, employment, and economics identified in Table F-2 or F-3 of Appendix F.

3.12 Environmental Justice

3.12.1 Description of the Affected Environment for Environmental Justice

Geographic analysis area: Following guidance in BOEM (2022), the GAA is large enough to identify any environmental justice communities potentially impacted by the Proposed Action within the following parameters. The GAA includes all counties adjacent to the Lease Area, as well as any area where Project offshore infrastructure may be visible. Counties adjacent to onshore Project infrastructure or ports used to support Project construction, O&M, and decommissioning activities in the Lease Area and along the RWEC are included in the GAA. In addition, the GAA includes counties adjacent to major ports that support commercial fisheries potentially affected by the Project. A map of the GAA is shown in Figure 3.12-1.

In identifying minority and low-income populations in the GAA, this analysis also considered geographically dispersed/transient sets of individuals who may experience common conditions of environmental exposure or effect (see guidance in CEQ [1997]). Environmental justice populations in the GAA that are geographically dispersed and/or transient include low-income and minority workers employed in potentially affected commercial fisheries (see Section 3.9) and service industries that support tourism (see Sections 3.11 and 3.18).

In a recent survey of commercial fishing crewmembers in the northeastern United States, approximately 13% of survey participants identified their race as Black, Asian, American Indian/Alaska Native, or Native Hawaiian/Pacific Islander, and 7% identified as Hispanic or Latino (Silva et al. 2021). Approximately 9% of participants reported annual incomes of less than $30,000. Because of increasing real estate values and tax burdens in many coastal communities in the northeastern United States (Jimenez 2021), many crewmembers, especially those with low incomes, reside in communities far from the ports where fishing vessels are based. According to survey results, the median distance crewmembers reported traveling from their homes to their primary ports was approximately 15 miles (Silva et al. 2021). Many crewmembers that work in the lucrative scallop fishery primarily based in New Bedford, Massachusetts, live in states such as Maine, New Jersey, and Virginia. Over the past several years many U.S. seafood processors have relied on the H-2B visa program to fill lower-wage jobs (National Guestworker Alliance 2016; New American Economy 2017; Strauss 2017). This visa program allows employers to bring low-skilled foreign workers into the United States to fill temporary and seasonal jobs in sectors other than agriculture (Zavodny and Jacoby 2010). It is likely that the majority of these foreign workers hired by seafood processors belong to minority groups given that Mexico, Jamaica, Guatemala, and South Africa are among the primary home countries of H-2B visa workers (Batalova et al. 2021).

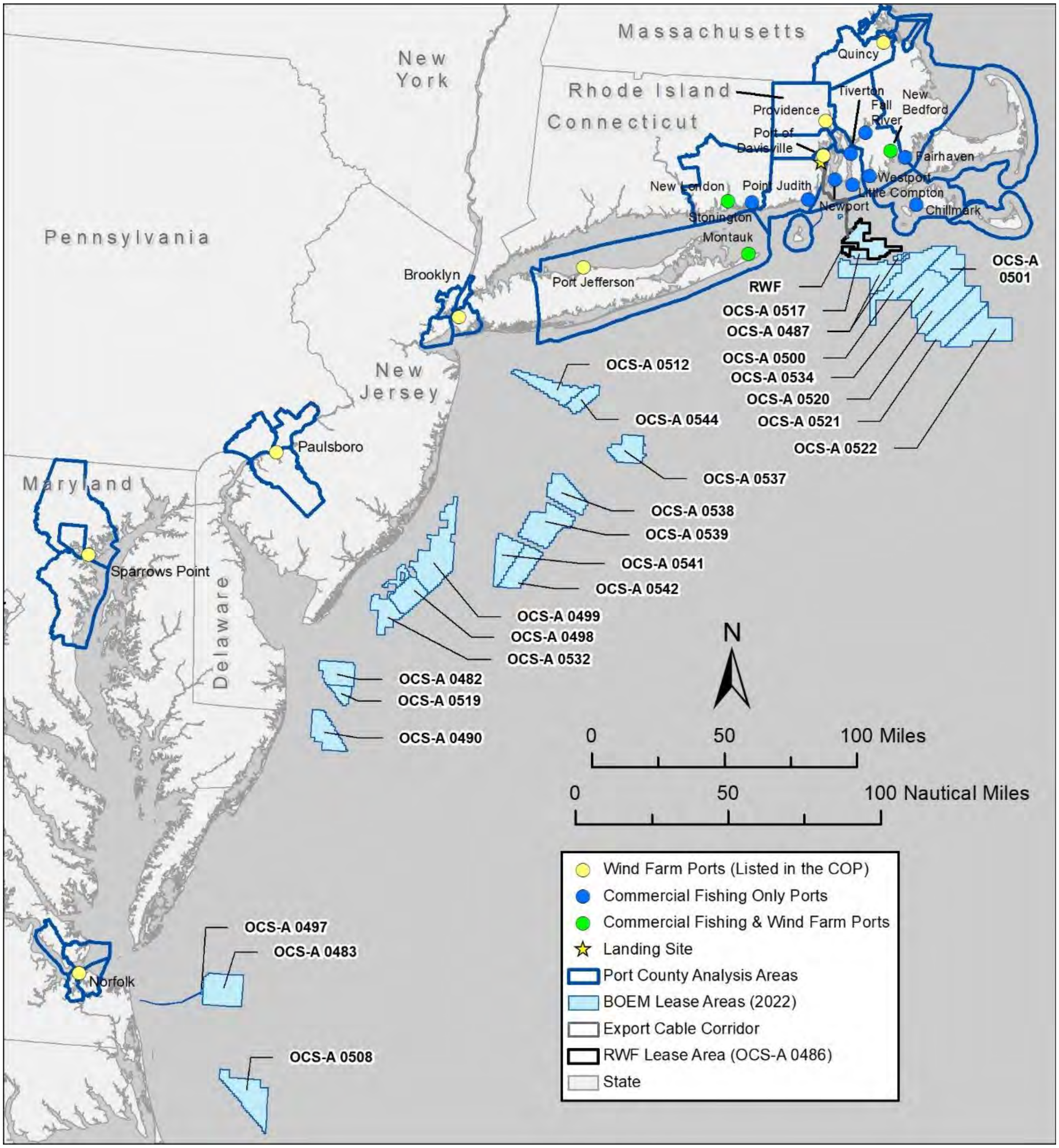

Figure 3.12-1. Geographic analysis area for environmental justice.

With respect to low-income and minority workers employed in service industries that support tourism, a large portion of the tourism workforce in the northeastern United States also consists of workers with H-2B visas (Gellerman 2017; Levin 2021; Terry 2018). Many other entry-level tourism jobs are filled by foreign workers with J-1 visas who are participating in the Summer Work Travel program. This program provides international students with an opportunity to work in the United States during their summer vacation from college or university (Forman 2022; Terry 2018). Tourism workers with H-2B or J-1 visas emigrate to the United States during the tourist season and return to their home countries after the season ends. It is likely that many of these individuals are also members of low-income populations since employees in the tourism-related leisure and hospitality industry have the lowest earnings in the U.S. economy (Dogru et al. 2019).

Another environmental justice community that is geographically dispersed consists of members of Native American tribes for whom there are resources of cultural significance in the GAA. Federally recognized tribal nations in the GAA include the Mashpee Wampanoag Tribe, Shinnecock Indian Nation, Mashantucket (Western) Pequot Tribal Nation, Wampanoag Tribe of Gay Head (Aquinnah), Mohegan Tribe of Indians of Connecticut, Narragansett Indian Tribe, Delaware Tribe of Indians, and Delaware Nation (see Appendix A). A substantial number of Native American people reside within or close to their traditional tribal areas. However, it is likely that tribal members are spread throughout the United States.

Affected environment: Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations) requires that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations, low-income populations, Native American tribes, and indigenous peoples" (EPA 2019).[39]

Table 3.12-1 describes environmental justice characteristics of the counties and cities/towns in the GAA. The table includes counties that contain or are adjacent to ports that may be used for Project construction, O&M, and decommissioning; contain major ports and commercial fisheries that could be affected by the Project; or contain the proposed Project landing site and onshore transmission cable. In addition, the table includes counties that contain cities/towns within the proposed visual study area as described in COP Appendix U1 (EDR 2021). The percentage of minority and low-income populations in each county and city/town were determined using the EPA's EJScreen tool, an environmental justice screening and mapping tool (EPA 2021b). Within that online tool, minority status determination is based on identifying individuals who are non-white or who are white but have Hispanic ethnicity. Low-income status determination is based on identifying individuals for whom the ratio of household income to the poverty level in the previous 12 months was less than two. Cities and counties in which more than half the population consists of minority groups include Baltimore City, Philadelphia, Hudson, New York, Kings, Suffolk, Hampton City, Portsmouth City, Newport News City, and Norfolk City. Counties in which more than one-third of the population is in the low-income group include Baltimore City, Philadelphia, Hudson, New York, Portsmouth City, Newport News City, and Norfolk City. Figures G-EJ1 though G-EJ6 show minority population percentages by block group for all counties in the GAA. Figures G-EJ7 through G-EJ12 show low-income population percentages by block groups in the same areas. Please also note that the shading in Table 3.12-1 is intentional and indicates groups of counites and/or cities and towns that are "adjacent to" counties that contain a wind farm port.

[39] The term *indigenous peoples* includes state-recognized tribes; indigenous and tribal community-based organizations; individual members of federally recognized tribes, including those living on a different reservation or living outside Indian country; individual members of state-recognized tribes; Native Hawaiians; Native Pacific Islanders; and individual Native Americans (EPA 2021a).

Table 3.12-1. Environmental Justice Characteristics of Counties and Cities/Towns in the Geographic Analysis Area

County, City/Town, State	Contains or is Adjacent to Staging Port	Contains Major Commercial Fishing Port	Within Visual Study Area	Port or Landing Site	Minority Percentage*	Low-Income Percentage†	City/Town Population Composition Rating‡	City/Town Poverty Rating§	City/Town Personal Disruption Rating¶	City/Town Housing Disruption Rating**	City/Town Retiree Migration Rating††	City/Town Urban Sprawl Rating‡‡
New London County, CT	X	X	X		24.1%	22.2%						
New London, CT	X	X		Port of New London	55.9%	41.5%	Medium–High	High	High	Low	Low	Low
Stonington, CT		X	X	Stonington	9.1%	15.8%	Medium–High	High	High	Low	Medium	Low
Bristol County, MA	X	X	X		18.1%	25.4%						
Fairhaven, MA	X	X	X	Fairhaven	9.9%	20.6%	Low	Low	Low	Medium	Medium	Medium
New Bedford, MA	X	X	X	New Bedford Marine Commerce Terminal	38.0%	42.4%	Medium–High	High	Medium–High	Medium	Low	Medium–High
Westport, MA		X	X	Westport	2.7%	16.2%	Low	Low	Low	Low	Low	High
Norfolk County, MA	X				26.0%	14.0%						
Quincy, MA	X			Cashman Shipyard	42.0%	24.0%	Medium–High	Medium	Low	Medium–High	Low	Medium–High
Suffolk County, MA	X				55.0%	32.0%						
Plymouth County MA	X		X		18.7%	17.8%						
Dukes County, MA		X	X		13.9%	23.6%						
Chilmark, MA		X	X	Chilmark/ Menemsha	10.0%	20.4%	Low	Low	Low	Medium	Medium–High	High
Anne Arundel County, MD	X				31.0%	14.7%						
Baltimore City, MD	X				72.5%	40.1%	Medium–High	High	Medium–High	Medium–High	Low	Medium–High
Baltimore County, MD	X				41.9%	21.9%						
Edgemere, MD	X			Sparrows Point	12.7%	19.9%	Low	Low	Low	Medium–High	Medium–High	Medium
Delaware County, PA	X				32.6%	22.6%						
Philadelphia County, PA	X				65.4%	44.4%						
Gloucester County, NJ	X				21.2%	17.1%						
Paulsboro, NJ#	X			Paulsboro Marine Terminal	33.5%	37.1%	Medium	High	Medium–High	Low	Low	Low
Suffolk County, NY	X	X	X		31.9%	17.1%						
Montauk, NY	X	X	X	Port of Montauk	17.9%	9.5%	Low	Low	Low	High	High	Medium–High
Brookhaven, NY	X			Port Jefferson	27.6%	16.7%	Low	Low	Low	Medium	Low	Medium–High
Richmond County, NY	X				38.3%	24.0%						

County, City/Town, State	Contains or is Adjacent to Staging Port	Contains Major Commercial Fishing Port	Within Visual Study Area	Port or Landing Site	Minority Percentage*	Low-Income Percentage[†]	City/Town Population Composition Rating[‡]	City/Town Poverty Rating[§]	City/Town Personal Disruption Rating[¶]	City/Town Housing Disruption Rating[**]	City/Town Retiree Migration Rating[††]	City/Town Urban Sprawl Rating[‡‡]
Hudson County NJ	X				71.1%	34.1%						
New York County, NY	X				53.1%	29.5%						
Kings County, NY	X				63.8%	40.1%						
Brooklyn, NY[#]	X			Port of Brooklyn	63.8%	40.1%	High	High	Medium–High	High	Low	High
Providence County, RI	X		X		38.5%	32.6%						
Providence, RI	X		X	Port of Providence[†]	66.5%	46.1%	High	High	High	Medium	Low	Medium
Washington County, RI	X	X	X		8.9%	18.1%						
Narragansett, RI		X	X	Point Judith	6.9%	25.6%	Low	Low	Low	Medium–High	Medium	Low
North Kingstown, RI	X		X	Port of Davisville at Quonset Point	8.5%	15.6%	Low	Low	Low	Low	Low	Low
Kent County, RI	X		X		11.0%	20.6%						
Newport County, RI		X	X		14.2%	18.8%						
Newport, RI		X	X	Newport	23.1%	25.8%	Low	Med	Low	High	Low	Medium
Little Compton, RI		X	X	Little Compton	5.3%	14.3%	Low	Low	Low	Medium–High	Medium–High	Medium
Tiverton, RI		X	X	Tiverton	5.3%	17.2%	Low	Low	Low	Low	Medium	Low
Hampton City, VA	X				61.4%	31.5%						
Portsmouth City, VA	X				62.0%	37.1%						
Newport News City, VA	X				56.6%	34.0%						
Norfolk City, VA	X				56.5%	35.6%						
Norfolk, VA	X			Port of Norfolk/ Norfolk Intl. Terminal	56.5%	35.6%	Medium	Medium–High	Medium–High	Medium	Low	Low
Barnstable County, MA			X		10.3%	20.1%						
Nantucket County, MA			X		14.9%	15.4%						
Bristol County, RI			X		7.7%	17.6%						

Sources: NMFS (2020); EPA (2021b).

Notes: CT = Connecticut, MA = Massachusetts, MD = Maryland, NJ = New Jersey, NY = New York, PA = Pennsylvania, RI = Rhode Island, VA = Virginia.

Groups of shaded and non-shaded rows represent separate county groups that include the counties in which affected port(s) are located, together with adjacent counties, if any. The last three rows show counties that are within the visual study area but do not contain affected ports.

Minority and low-income percentages are based on 2014–2018 American Community Survey 5-year summary file data obtained from EPA's EJScreen; population composition, poverty, and personal disruption ratings are for 2018.

* Minority percent calculated as 100 percent minus "White alone, non-Hispanic or Latino" percent.

[†] Low-income percent is "persons in poverty" percent.

[‡] Population composition corresponds to the demographic makeup of a community, including the percentage of minorities, the percent of young children and female-headed households, and the ability to speak English. A high rating indicates a more vulnerable population. For additional information see Jepson and Colburn (2013).

[§] Poverty is expressed as those receiving assistance, families below the poverty line, and individuals older than 65 and younger than 18 in poverty. A high rating indicates a high rate of poverty and a more vulnerable population. For additional information see Jepson and Colburn (2013).

[¶] Personal disruption captures unemployment status, educational attainment, poverty, and marital status. A high rating indicates less personal capacity to adapt to changes and thus a more vulnerable population. For additional information see Jepson and Colburn (2013).

** Housing disruption represents factors that indicate a fluctuating housing market where some displacement may occur due to rising home values and rents, including change in mortgage value. A high rank means more vulnerability for those in need of affordable housing and a population more vulnerable to gentrification. For additional information see Jepson and Colburn (2013).

†† Retiree migration characterizes communities with a higher concentration of retirees and elderly people in the population, including households with inhabitants over 65 years; populations receiving social security or retirement income; and level of participation in the work force. A high rank indicates a population more vulnerable to gentrification as retirees seek out the amenities of coastal living. For additional information see Jepson and Colburn (2013).

‡‡ Urban sprawl describes areas experiencing gentrification through increasing population density, proximity to urban centers, home values, and cost of living. A high rank indicates a population more vulnerable to gentrification. For additional information see Jepson and Colburn (2013).

Data reported for the borough.

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In addition to showing the minority and low-income percentages in the GAA, Table 3.12-1 presents environmental justice indices provided by NMFS (2020) that describe the social vulnerability of coastal communities engaged in fishing activities in terms of existing local social conditions that are likely to determine how potentially disruptive events affect communities. Brooklyn and Providence have highly vulnerable populations based on demographic makeup; New London, Stonington, New Bedford, Paulsboro, Brooklyn, Baltimore City, and Providence have highly vulnerable populations based on poverty level; and New London, Stonington, and Providence have highly vulnerable populations based on personal capacity to adapt to changes. A low population composition and poverty rating for the communities listed in Table 3.12-1 does not necessarily mean that the fishing industries in those communities do not have a high proportion of minority and low-income individuals. As discussed above, a large number of workers in the commercial fishing industry in the GAA, especially those with low incomes, reside in communities distant from the ports where fishing vessels are based and where fish are landed and processed.

Table 3.12-1 also shows social indicators related to gentrification pressure, including housing disruption, retiree migration, and urban spawl. Coastal development that leads to gentrification of coastal communities may create space-use conflicts and reduce access to coastal areas and working waterfronts that communities rely on for recreation, employment, and commercial or subsistence fishing. Housing disruption caused by rising home values and rents can displace affordable housing, with disproportionate effects for low-income populations. On the other hand, gentrification can also lead to increased tourism and recreational boating and fishing, which provide employment opportunities for members of environmental justice populations in recreation and tourism. The gentrification indices in Table 3.12-1 show medium–high to high levels of housing disruption in Edgemere, Montauk, Brooklyn, Narragansett, Newport, Quincy, and Little Compton; medium–high to high levels of retiree migration in Edgemere, Montauk, Chilmark, and Little Compton; and medium–high to high levels of urban sprawl in Westport, Brookhaven, Montauk, Chilmark, New Bedford, Quincy, and Brooklyn. Following EPA (1999) and EPA (2016a) guidelines, this analysis also identified potential environmental justice areas of concern (i.e., geographical areas that contain relatively high concentrations or “pockets” of minority and/or low-income populations) within cities/towns that contain ports that may be used for Project construction staging or contain the proposed Project landing site and onshore transmission cable. These areas were described at the level of the census block group, which represents the smallest census geographic unit for which both race/ethnicity and income data are readily available. Minority and low-income populations in block groups were identified using the EPA’s EJScreen tool (EPA 2021b). In accordance with thresholds defined in CEQ (1997), a block group was determined to be a potential environmental justice area of concern if 1) the minority population exceeds 50%, or 2) the minority or low-income population percentage is meaningfully greater than the minority or low-income population percentage in a reference population. The reference population for this analysis is the county in which the block group is located. Using an approach outlined by Hartell (2007) and consistent with guidance in EPA (2016a), the decision threshold when there is a “meaningfully greater” percentage of minority or low-income individuals than in the reference population was based on the following equation:

(minority or low-income population in block group/total population in block group)
divided by
(minority or low-income population in county/total population in county)

If the equation results in a number greater than 1, a greater proportion of minority or low-income individuals resides in the block group than in the county as a whole. This decision threshold is conservative (i.e., any percentage in a given block group that is greater than the percentage in the reference area qualifies as being meaningfully greater).

Based on the above definition, Table 3.12-2 and Table 3.12-3 show the block groups in the cities/towns that contain the Project landing site or ports that may support Project construction, O&M, or decommissioning activities that are potential environmental justice areas of concern. Of the estimated 6,112 total block groups in affected counties, approximately 46% were determined to be potential environmental justice areas of concern because of the concentrations of minority populations, whereas approximately 43% had concentrations of low-income populations. Cities/towns that contain possible staging ports where more than half of the block groups are potential environmental justice areas of concern include New London, New Bedford, Paulsboro, Brooklyn, Providence, Quincy, and Norfolk. A concentration of minority and low-income populations also occur in a three-census block area to the northwest of the Sparrows Point port facility. Figures G-EJ13 through G-EJ18 in Appendix G show the distribution of block groups of potential environmental justice concern in the potentially affected counties. Tables G-EJ1 through G-EJ28 in Appendix G list the multi-digit identifier of each block group of potential environmental justice concern based on minority population, low-income population, or both. The block group identifiers are organized by county and sub-county name (city, town, or census designated place).

The landfall work area at Quonset Point in North Kingstown, Rhode Island, has been developed for industrial use. The onshore transmission cable route connecting the point of RWEC landfall with the OnSS and ICF would be approximately 1.0 mile long and would begin in the industrial area, follow the existing roadway ROW, and end in an undeveloped area adjacent to the existing Davisville Substation (see Figure 2.1-2). The closest residences to the construction and installation of the onshore transmission cable, ICF, and OnSS are the residences on the south side of Camp Avenue and east side of Mill Creek Drive, which are within a few hundred feet of the construction area. The block group in which all the onshore Project infrastructure would be located is a potential environmental justice area of concern based on both minority population and low-income population criteria. However, the portion of this block group that is immediately adjacent to the landfall envelope area, OnSS, and ICF is limited to industrial, utility, and undeveloped land uses (see Section 3.14). The block group in which most of the closest residences to the proposed onshore Project infrastructure is located is not a potential environmental justice area of concern based on either minority population or low-income population criteria.

Table 3.12-2. Census Block Groups in Counties and Cities/Towns that Are Potential Environmental Justice Areas of Concern Due to Concentrations of Minority Populations

County, City/Town, State	Staging Port or Landing Site	Population	Number of Block Groups	Percentage of Block Groups of Potential Environmental Justice Concern Due to Minority Population (%)	Total Population of Block Groups of Potential Environmental Justice Concern Due to Minority Population	Minority Percentage of Population in Block Groups of Potential Environmental Justice Concern (%)
New London County, CT		268,881	188	33.0%	95,319	47.3%
New London, CT	Port of New London	27,032	20	80.0%	20,688	67.3%
Bristol County, MA		558,905	390	41.0%	207,111	35.5%
New Bedford, MA	New Bedford Marine Commerce Terminal	95,117	87	74.7%	70,058	47.6%
Norfolk County, MA		698,249	474	40.1%	286,676	41.1%
Quincy, MA	Cashman Shipyard	94,121	72	76.4%	76,931	81.7%
Baltimore County, MD		827,625	529	36.7%	359,380	71.2%
Edgemere, MD	Sparrows Point	7,661	8	0.0%	0	0
Census Tract 4213 in Dundalk, MD	Sparrows Point (adjacent area)*	3,281	3	100%	3,281	78.1%
Gloucester County, NJ		290,852	191	34.6%	122,217	35.3%
Paulsboro, NJ	Paulsboro Marine Terminal	5,937	7	71.4%	4,624	41.4%
Suffolk County, NY		1,487,901	999	31.7%	547,678	59.8%
Montauk, NY	Port of Montauk	3,268	5	40.0%	1,470	35.0%
Brookhaven, NY	Port Jefferson	485,363	301	29.9%	162,691	47.2%
Kings County, NY		2,600,747	2,085	61.1%	1,696,907	83.7%

County, City/Town, State	Staging Port or Landing Site	Population	Number of Block Groups	Percentage of Block Groups of Potential Environmental Justice Concern Due to Minority Population (%)	Total Population of Block Groups of Potential Environmental Justice Concern Due to Minority Population	Minority Percentage of Population in Block Groups of Potential Environmental Justice Concern (%)
Brooklyn, NY	Port of Brooklyn	2,600,747	2,085	61.1%	1,696,907	83.7%
Providence County, RI		634,533	499	41.1%	260,963	70.4%
Providence, RI	Port of Providence	179,435	154	79.2%	144,665	76.5%
Washington County, RI		126,242	94	27.7%	46,393	16.9%
North Kingstown, RI	Port of Davisville at Quonset Point	26,207	20	30.0%	6,890	19.4%
Norfolk City, VA		245,592	189	55.0%	136,196	75.9%
Norfolk, VA	Port of Norfolk/ Norfolk Intl. Terminal	245,592	189	55.0%	136,196	75.9%

Source: EPA (2021b).

Notes: Table includes 2014–2018 American Community Survey 5-year summary file data obtained from the EPA’s EJScreen tool.

CT = Connecticut, MA = Massachusetts, MD = Maryland, NJ = New Jersey, NY = New York, PA = Pennsylvania, RI = Rhode Island, VA = Virginia.

* Includes three block groups in Dundalk to the northwest of Sparrows Point (24/005/4213/1, 24/005/4213/2, and 24/005/4213/3).

Table 3.12-3. Census Block Groups in Counties and Cities/Towns that Are Potential Environmental Justice Areas of Concern Due to Concentrations of Low-Income Populations

County, City/Town, State	Staging Port or Landing Site	Population	Number of Block Groups	Percentage of Block Groups of Potential Environmental Justice Concern Due to Low-Income Population (%)	Total Population of Block Groups of Potential Environmental Justice Concern Due to Low-Income Population	Low-Income Percentage of Population in Block Groups of Potential Environmental Justice Concern (%)
New London County, CT		268,881	188	37.2%	99,712	39.0%
New London, CT	Port of New London	27,032	20	75.0%	20,893	49.9%
Bristol County, MA		558,905	390	47.9%	226,236	44.5%
New Bedford, MA	New Bedford Marine Commerce Terminal	95,117	87	81.6%	76,655	48.7%
Norfolk County, MA		698,249	474	41.6%	282,434	40.4%
Quincy, MA	Cashman Shipyard	94,121	72	76.4%	77,517	82.4%
Baltimore County, MD		827,625	529	39.7%	345,838	35.9%
Edgemere, MD	Sparrows Point	7,661	8	25.0%	1,615	27.0%
Census Tract 4213 in Dundalk, MD	Sparrows Point (adjacent area)*	3,281	3	100%	3,281	56.2%
Gloucester County, NJ		290,852	191	48.7%	122,283	29.1%
Paulsboro, NJ	Paulsboro Marine Terminal	5,937	7	85.7%	5,279	40.5%
Suffolk County, NY		1,487,901	999	41.3%	630,645	28.2%
Montauk, NY	Port of Montauk	3,268	5	0.0%	0	0.0%
Brookhaven, NY	Port Jefferson	485,363	301	45.2%	211,525	26.3%

County, City/Town, State	Staging Port or Landing Site	Population	Number of Block Groups	Percentage of Block Groups of Potential Environmental Justice Concern Due to Low-Income Population (%)	Total Population of Block Groups of Potential Environmental Justice Concern Due to Low-Income Population	Low-Income Percentage of Population in Block Groups of Potential Environmental Justice Concern (%)
Kings County, NY		2,600,747	2,085	42.8%	1,237,027	57.6%
Brooklyn, NY	Port of Brooklyn	2,600,747	2,085	42.8%	1,237,027	57.6%
Providence County, RI		634,533	499	45.7%	286,540	51.7%
Providence, RI	Port of Providence	179,435	154	73.4%	136,695	54.2%
Washington County, RI		126,242	94	45.7%	61,309	26.9%
North Kingstown, RI	Port of Davisville at Quonset Point	26,207	20	45.0%	8,810	31.6%
Norfolk City, VA		245,592	189	52.9%	145,767	45.5%
Norfolk, VA	Port of Norfolk/ Norfolk Intl. Terminal	245,592	189	52.9%	145,767	45.5%

Source: EPA (2021b)

Notes: Table includes 2014–2018 American Community Survey 5-year summary file data obtained from the EPA's EJScreen tool.

CT = Connecticut, MA = Massachusetts, MD = Maryland, NJ = New Jersey, NY = New York, PA = Pennsylvania, RI = Rhode Island, VA = Virginia.

* Includes three block groups in Dundalk to the northwest of Sparrows Point (24/005/4213/1, 24/005/4213/2, and 24/005/4213/3).

Guidance provided by the CEQ (1997) indicates that potential impacts on the social or cultural practices of Native American tribes as a result of impacts to the natural or physical environment should be assessed as potential environmental justice impacts. The connection of Native American tribes to marine fisheries within or in proximity to the RI/MA WEAs has been established in academic literature (Chaves 2014; Trigger 1978). During government-to-government consultations with BOEM, representatives from federally recognized tribes expressed concerns about a variety of potential impacts to culturally significant environmental and physical resources (see Appendix A).

BOEM acknowledges Mashpee Wampanoag Tribe's reverence for the NARW and has given careful consideration to the potential impacts to NARWs throughout development of the EIS, focused within EIS Section 3.15, Marine Mammals. BOEM is also consulting with NMFS under the ESA and would require compliance with all mitigation and reporting measures in the NMFS biological opinion if the COP were approved or approved with modification.

Executive Order 13175 commits federal agencies to engage in government-to-government consultation with tribes. A description of the government-to-government consultations that BOEM conducted with federally recognized tribes is provided in Appendix A.

3.12.2 Environmental Consequences

3.12.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

This EIS analyzes the maximum-case scenario; any potential variances in the proposed Project build-out as defined in the PDE would result in impacts similar to or less than those described in the sections below. The following proposed PDE parameters (see Appendix D) would influence the magnitude of the impacts on the economic welfare and health and safety of environmental justice populations:

- Overall size of the Project and number of WTGs constructed
- The Project layout including the type, height, and placement of the WTGs and OSS, and the design and visibility of lighting on the structures
- The port(s) selected to support construction, installation, and decommissioning and the port(s) selected to support O&M
- The time of year during which onshore and nearshore construction occurs

These Project design parameters would influence the magnitude of adverse impacts to environmental justice populations primarily through economic and public health and safety impacts associated with increases in air emissions, noise, and traffic; decreases in water quality; job and income losses due to the disruption of commercial fisheries, for-hire recreational fishing, or the tourism industry; adverse impacts to subsistence fishing activities; visual impacts on resources culturally important to Native American tribes; and damage to submerged ancient landforms that have cultural significance to Native American tribes. However, EPMs implemented during construction, O&M, and decommissioning would decrease the potential for impacts to environmental justice populations (see Table F-1 in Appendix F). These EPMs would be implemented across all alternatives; therefore, BOEM would not expect measurable potential variances in impacts across the alternatives.

See Appendix E1 for a summary of IPFs analyzed for environmental justice across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have a negligible adverse effect are excluded from Chapter 3 and provided in Table E2-11 in Appendix E1.

Table 3.12-4 provides a summary of IPF findings carried forward for analysis in this section. Each alternative analysis discussion consists of the construction and installation phase, the O&M phase, the decommissioning phase, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion. A detailed analysis of the Proposed Action is provided following the table. Detailed analysis of other considered action alternatives is also provided below the table if analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component.

The Conclusion section within each action alternative analysis discussion includes rationale for the effects determinations. Under all of the active alternatives, the overall impact to environmental justice populations from any alternative would be **minor** to **moderate** adverse and **minor** beneficial as EPMs would reduce adverse impacts substantially during the life of the proposed Project, including decommissioning; the affected activity or community would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts of the Project; or once the impacting agent is gone, the affected activity or community, including traditional cultural practices, is expected to return to a condition with no measurable impacts, when remedial or mitigating action is taken. For IPFs with potential for disproportionately high and adverse impacts on communities with environmental justice concerns, BOEM discloses whether the impacts could be disproportionately high and adverse without EPMs, and whether they would remain so with EPMs. Determination of whether impacts could be disproportionately high and adverse is informed by analysis of other resources analyzed in the Final EIS, along with consideration for unique vulnerabilities and cultural concerns of environmental justice populations. The factors that may contribute to certain populations experiencing disproportionate impacts are discussed in Section 3.12.1, Description of the Affected Environment. Discussion of the impacts and their potential to be disproportionately high and adverse is provided in Table 3.12-4 and in Sections 3.12.2.2 through 3.12.2.3.

Where feasible, calculations for specific alternative impacts are provided in Appendix E4 to facilitate reader comparison across alternatives.

Table 3.12-4. Alternative Comparison Summary for Environmental Justice

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
Accidental releases and discharges	**Onshore**: Offshore wind energy development would comply with all regulatory requirements for water quality protection. Therefore, environmental justice populations in the GAA are expected to experience **negligible** adverse impacts.	**Onshore**: EPMs implemented would avoid or reduce potential spill impacts on water quality. Moreover, there are no waterbodies in the path of the onshore transmission cable or on the OnSS or ICF parcels that could be contaminated by an accidental release and discharge resulting from equipment failure or mismanagement during construction. Therefore, impacts to the health and safety of environmental justice populations associated with changes in water quality would be short term **negligible** adverse. To the extent that decreases in water quality occur as a result of ongoing and future onshore activities, environmental justice populations could experience adverse environmental and health effects. However, onshore and offshore development, including the Proposed Action, would comply with all regulatory requirements for water quality protection. Therefore, when combined with past, present, and other reasonably foreseeable projects, the Project would have short-term **negligible** to **minor** adverse impacts.	**Onshore**: Construction, O&M, and decommissioning of onshore facilities under Alternatives C through F would not be markedly different from the Proposed Action; therefore, impacts on the health and safety of environmental justice populations would be similar to the Proposed Action: short term **negligible** to **minor** adverse.				**Onshore**: Construction, O&M, and decommissioning of onshore facilities under Alternative G would not be markedly different from the Proposed Action; therefore, impacts on the health and safety of environmental justice populations would be similar to the Proposed Action: short term **negligible** to **minor** adverse.
Air emissions	**Offshore**: During construction, impacts from future wind development activities on air quality would be temporary and **minor** to **moderate** and could result in short-term disproportionately high and adverse health and safety impacts to environmental justice populations, especially if multiple offshore wind projects simultaneously use the same port for construction staging. During operations, offshore wind energy projects would reduce the need for fossil fuel–combusting power generation, which would have a net beneficial impact on air quality. Therefore, the overall air quality impacts of offshore wind energy development on the health and safety of environmental justice populations would be **minor** to **moderate** beneficial.	**Offshore**: During Project construction, the air emissions near mustering ports would be temporary and **minor** adverse. Therefore, the air quality impacts on the health and safety of environmental justice populations near the ports would be short term **minor** adverse. During operations, the Projects would reduce the need for fossil fuel–combusting power generation, which would have a net beneficial impact on air quality. Therefore, the overall air quality impacts of the Project on the health and safety of environmental justice populations would be long term **minor** beneficial. Despite the potential for increased air emissions during construction of the Project and other new offshore wind energy projects, over the long term, the reduction in the need for fossil fuel–combusting power generation would have a net beneficial impact on air quality in the GAA. Therefore, the air quality improvements from offshore wind energy development would have a long-term **minor** to **moderate** beneficial impact.	**Offshore**: Under Alternatives C through F, the air emissions impact level due to a change in air pollutant emissions would be similar to the Proposed Action. Therefore, the air emissions impact to the health and safety of environmental justice populations would be similar to the Proposed Action: short term **minor** adverse during construction and decommissioning and long term **minor** to **moderate** beneficial during operations.				**Offshore**: Under Alternative G, the air emissions impact level due to a change in air pollutant emissions would be similar to the Proposed Action. Therefore, the air emissions impact to the health and safety of environmental justice populations would be similar to the Proposed Action: short term **minor** adverse during construction and decommissioning and long term **minor** to **moderate** beneficial during operations.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	Onshore: State and local agencies would be responsible for managing actions to help minimize and avoid air quality impacts of offshore wind energy projects on neighborhoods during onshore construction. Therefore, the onshore activities are expected to have short-term **minor** adverse impacts on the health and safety of environmental justice populations.	**Onshore**: The potential impacts from construction and diesel-generating equipment would be reduced through EPMs related to fuel-efficient engines and dust control plans. Therefore, impacts to the health and safety of environmental justice populations near the landing site and onshore transmission cable route associated with changes in air quality during Project construction would be short term **minor** adverse. Impacts to air quality from Project onshore facilities' O&M emissions would be **negligible** adverse. State and local agencies would be responsible for minimizing and avoiding air quality impacts of ongoing and future onshore activities on nearby neighborhoods, including those neighborhoods in which environmental justice populations reside. Therefore, the overall cumulative air quality impacts on the health and safety of environmental justice populations are expected to be long term **minor** to **moderate** adverse.	**Onshore**: Construction and installation, O&M, and decommissioning of onshore facilities under Alternatives C through F would not be markedly different from the Proposed Action; therefore, impacts would be similar to the Proposed Action: short term **negligible** to **minor** adverse on the health and safety of environmental justice populations near affected ports, short term **minor** adverse on the health and safety of environmental justice populations near the proposed landing sites and onshore transmission cable route, long term **negligible** adverse during Project O&M, and long term **negligible** adverse during decommissioning. Cumulative impacts to the health and safety of environmental justice populations would be similar to the Proposed Action: long term **minor** to **moderate** adverse.				**Onshore**: Construction and installation, O&M, and decommissioning of onshore facilities under Alternative G would not be markedly different from the Proposed Action; therefore, impacts would be similar to the Proposed Action: short term **negligible** to **minor** adverse on the health and safety of environmental justice populations near affected ports, short term **minor** adverse on the health and safety of environmental justice populations near the proposed landing sites and onshore transmission cable route, long term **negligible** adverse during Project O&M, and long term **negligible** adverse during decommissioning. Cumulative impacts to the health and safety of environmental justice populations would be similar to the Proposed Action: long term **minor** to **moderate** adverse.
Climate change	**Offshore**: Future offshore wind energy project GHG emissions during construction would be short term **negligible** adverse as compared to aggregate global emissions. During O&M, these projects would contribute to a broader combination of actions to reduce future impacts on the health and safety of environmental justice populations from climate change trends over the long term. However, given the global scale of GHG emissions, the reduction in GHG emissions resulting from the Project would have a long-term **negligible** beneficial impact on the health and safety of environmental justice populations.	**Offshore**: Project GHG emissions during construction would be short term **negligible** adverse. During operations, the Project would contribute to a broader combination of actions to reduce future impacts on the health and safety of environmental justice populations from climate change trends over the long term. However, given the global scale of GHG emissions, the reduction in GHG emissions resulting from offshore wind energy development would have a long-term **negligible** beneficial impact on the health and safety of environmental justice populations The Proposed Action, together with other future offshore wind energy projects, could beneficially contribute to a broader combination of actions to reduce future impacts from climate change trends over the long term. However, the overall cumulative impact of climate change trends on the health and safety of environmental justice populations is expected to be long term **major** adverse.	**Offshore**: The climate change trends impact level of Alternatives C through F due to a change in GHG emissions would be similar to the Proposed Action. Therefore, the climate change trends impact to the health and safety of environmental justice populations would be similar to the Proposed Action: long term **negligible** beneficial. Likewise, the cumulative impacts of climate change trends on the health and safety of environmental justice populations would be similar to the Proposed Action: long term **major** adverse.				**Offshore**: The climate change trends impact level of Alternative G due to a change in GHG emissions would be similar to the Proposed Action. Therefore, the climate change trends impact to the health and safety of environmental justice populations would be similar to the Proposed Action: long term **negligible** beneficial. Likewise, the cumulative impacts of climate change trends on the health and safety of environmental justice populations would be similar to the Proposed Action: long term **major** adverse.
Light	**Offshore**: Visual impacts on recreation and tourism would be short term during construction and long term during O&M, with negligible to moderate adverse impacts, based on the observed	**Offshore**: Visual impacts on recreation and tourism would be short term with **negligible** to **moderate** adverse impacts during construction, based on the observed distance and individual responses by recreationists and visitors to changes in the	**Offshore**: If certain WTG positions are omitted under Alternatives C through F, the adverse impacts of light on tourism-related service industries that are a source of employment for low-income workers would be reduced. In addition, the adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations would be reduced. However, the impact				**Offshore**: If certain WTG positions are omitted under Alternative G, the adverse impacts of light on tourism-related service industries that are a source of employment for low-income workers would be reduced. In addition, the adverse

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	distance and individual responses by recreationists and visitors to changes in the viewshed. Therefore, economic impacts to members of environmental justice populations employed in tourism-related service industries are expected to be short term to long term **minor** to **moderate** adverse during construction and O&M. If ADLS (or a similar system) is installed on WTGs in offshore wind energy projects, impacts to environmental justice populations would be reduced to **negligible** to **minor** adverse. Lighting on WTGs could also affect cultural resources, including views of the night sky and ocean that are important to Native American tribes. ADLS would reduce the impacts on cultural resources but adverse impacts on Native American tribes would continue. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects of offshore wind energy development, and the resolution of these adverse effects. Given that adverse lighting impacts on target species catch in commercial and for-hire recreational fisheries are expected to be localized and long term, the adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **minor** to **moderate** adverse.	viewshed. Therefore, economic impacts to members of environmental justice populations employed in tourism-related service industries are expected to be short term **negligible** to **moderate** adverse during construction. Revolution Wind has committed to implement ADLS as a measure to reduce light impacts. Therefore, economic impacts to members of environmental justice populations employed in tourism-related service industries are expected to be long term **negligible** adverse during O&M. Lighting on WTGs could also affect cultural resources, including views of night sky and the ocean that are important to Native American tribes. ADLS would reduce the impacts on Native American tribes associated with WTG lighting but adverse impacts would continue. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects. Because adverse lighting impacts on species targeted by commercial and for-hire recreational fisheries are expected to be localized and long term, the adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **negligible** to **minor** adverse. Cumulatively, aviation hazard lighting from the WTGs associated with the No Action Alternative and Proposed Action could be visible from coastal locations. The use of ADLS would reduce impacts to tourism, thereby reducing the economic impact of lighting on members of environmental justice populations employed in tourism-related service industries to long term **negligible** adverse. The Proposed Action when combined with ongoing and reasonably foreseeable activities could have adverse light impacts on viewshed resources important to Native American tribes. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects of offshore wind energy development, and the resolution of these adverse effects.	level for members of environmental justice populations employed in tourism-related service industries would still be similar to the Proposed Action: short term **negligible** to **moderate** adverse during construction and decommissioning and long term **negligible** adverse during operations. The impact level for members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would also be similar to the Proposed Action: short term **negligible** to **minor** adverse during construction and decommissioning and long term **negligible** to **minor** adverse during operations. In addition, omission of certain WTG positions would reduce the adverse impacts of lighting to viewsheds important to Native American tribes. In particular, Alternative E is primarily focused on setbacks of WTGs from Martha's Vineyard and would effectively increase distances of Project lights to viewshed resources important to Native American tribes at Aquinnah. However, the light impact level under Alternatives C through F would be similar to the Proposed Action. The light Impact of Alternatives C through F would not be markedly different from the Proposed Action. Therefore, the cumulative economic impacts on members of environmental justice populations employed in tourism-related service industries would be similar to the Proposed Action: long term **negligible** adverse. The cumulative impacts to Native American tribes from the combined lighting impacts of ongoing and planned actions on cultural resources would be similar to the Proposed Action. The cumulative economic impacts to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be similar to the Proposed Action: long term **minor** to **moderate** adverse.				impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations would be reduced. However, the impact level for members of environmental justice populations employed in tourism-related service industries would still be similar to the Proposed Action: short term **negligible** to **moderate** adverse during construction and decommissioning and long term **negligible** adverse during operations. The impact level for members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would also be similar to the Proposed Action: short term **negligible** to **minor** adverse during construction and decommissioning and long term **negligible** to **minor** adverse during operations. In addition, omission of certain WTG positions would reduce the adverse impacts of lighting to viewsheds important to Native American tribes in particular. However, the light impact level under Alternative G would be similar to the Proposed Action. The light impact of Alternative G would not be markedly different from the Proposed Action. Therefore, the cumulative economic impacts on members of environmental justice populations employed in tourism-related service industries would be similar to the Proposed Action: long term **negligible** adverse. The cumulative impacts to Native American tribes from the combined lighting impacts of ongoing and planned actions on cultural resources would be similar to the Proposed Action. The cumulative economic impacts to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be similar to the Proposed Action: long term **minor** to **moderate** adverse.

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		The cumulative adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be short term **minor** to **moderate** adverse.					
New cable emplacement/ maintenance	**Offshore**: The cable emplacement impacts on submerged marine cultural resources from offshore wind energy development could have long-term adverse disproportionate impacts on Native American tribes that trace their ancestry to these resources. If an ancient, submerged landform is disturbed during offshore cable emplacement, the impact on the cultural resource would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. The impact on Native American tribes would be long term **negligible** to **minor** adverse if offshore wind energy project construction and installation, O&M, and decommissioning can avoid these cultural resources. The economic impacts of new cable emplacement and maintenance to environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be similar to those discussed under the presence of structures IPF: long term **negligible** to **major** adverse depending on the fishery and fishing operation.	**Offshore**: If submerged ancient landforms are disturbed during offshore cable emplacement, the impact on the cultural resource would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. If Project construction is able to avoid these cultural resources, the impact on Native American tribes would be long term **negligible** to **minor** adverse. Revolution Wind could conduct O&M activities on equipment in areas that previously experienced disturbance during construction, thereby reducing impacts to submerged marine cultural resources to long term but **negligible** adverse. Impacts during Project decommissioning would be similar to impacts during construction: long term **negligible** to **minor** adverse if Project decommissioning is able to avoid cultural resources. The economic impacts of new cable emplacement and maintenance to environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be similar to those discussed below under the presence of structures IPF: short term **negligible** to **moderate** adverse during construction and decommissioning and long term **negligible** to **moderate** adverse during operations. The cable emplacement impacts on submerged marine cultural resources from ongoing and future offshore activities, including the Project, could have long-term **major** adverse disproportionate impacts on Native American tribes if these cultural resources are disturbed. If the Proposed Action, together with ongoing and reasonably foreseeable activities, are able to avoid these cultural resources, the impact on Native American tribes would be long term **negligible** to **minor** adverse. The cumulative adverse economic effects of new cable emplacement and maintenance to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **moderate** to **major**	**Offshore**: If the length of IACs is reduced under Alternatives C through F, the adverse impacts of new cable emplacement and maintenance on submerged ancient landforms important to Native American tribes could be reduced. However, the new cable emplacement and maintenance impact level for cultural resources would still be similar to the Proposed Action: long term **negligible** to **minor** adverse if construction and decommissioning are able to avoid cultural resources and long term **major** adverse if construction and decommissioning disturb cultural resources. Impacts during Project O&M would be long term but **negligible** adverse. In addition, reducing the length of IACs would lessen adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations. However, the new cable emplacement and maintenance impact level for commercial fisheries and for-hire recreational fishing would still be similar to the Proposed Action: short term **moderate** adverse for construction and decommissioning and long term **moderate** adverse during operations. The impact of Alternatives C through F would not be markedly different from the Proposed Action. Therefore, the cumulative economic impacts on members of environmental justice populations employed in commercial and for-hire recreational fisheries would be similar to the Proposed Action: long term **moderate** to **major** adverse depending on the fishery and fishing operation. The cumulative impacts to Native American tribes that trace their ancestry to submerged marine cultural resources would be similar to the Proposed Action: long term **major** adverse if these cultural resources are disturbed, and long term **negligible** to **minor** adverse if disturbance of these cultural resources is avoided.				**Offshore**: If the length of IACs is reduced under Alternative G, the adverse impacts of new cable emplacement and maintenance on submerged ancient landforms important to Native American tribes could be reduced. However, the new cable emplacement and maintenance impact level for cultural resources would still be similar to the Proposed Action: long term **negligible** to **minor** adverse if construction and decommissioning are able to avoid cultural resources and long term **major** adverse if construction and decommissioning disturb cultural resources. Impacts during Project O&M would be long term but **negligible** adverse. In addition, reducing the length of IACs would lessen adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations. However, the new cable emplacement and maintenance impact level for commercial fisheries and for-hire recreational fishing would still be similar to the Proposed Action: short term **moderate** adverse for construction and decommissioning and long term **moderate** adverse during operations. The impact of Alternative G would not be markedly different from the Proposed Action. Therefore, the cumulative economic impacts on members of environmental justice populations employed in commercial and for-hire recreational fisheries would be similar to the Proposed Action: long term **moderate** to **major** adverse depending on the fishery and fishing operation. The cumulative impacts to Native American tribes that trace their ancestry to submerged marine cultural resources would be similar to the Proposed Action: long term **major** adverse if these cultural resources are disturbed, and long term **negligible** to **minor** adverse if disturbance of these cultural resources is avoided.

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		adverse depending on the fishery and fishing operation.					
	Onshore: Activities associated with construction of the onshore components of future offshore wind energy projects, such as emplacement of onshore cables and new building construction, could physically disturb archaeological sites that have cultural significance to Native American tribes in the GAA as part of ancient and ongoing tribal practices. If archaeological sites that have cultural significance to tribes are disturbed during onshore construction, the impact on these cultural resources would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. The adverse impact on Native American tribes would be long term **negligible** to **minor** if offshore wind energy project construction and installation, O&M, and decommissioning are able to avoid these cultural resources.	**Onshore**: Activities associated with construction of the onshore components of the Project, such as emplacement of onshore cables and new building construction, could physically disturb archaeological sites that have cultural significance to Native American tribes in the GAA as part of ancient and ongoing tribal practices. If archaeological sites that have cultural significance to tribes are disturbed during onshore construction, the impact on these cultural resources would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. If Project construction is able to avoid these cultural resources, the impact on Native American tribes would be long term **negligible** to **minor** adverse. The construction of the onshore Project components would result in modification to the existing viewshed because the OnSS and ICF infrastructure could be visible. Given the cultural significance of viewshed resources to Native American tribes, the visibility of these structures has the potential to adversely affect environmental justice populations. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects. If archaeological sites that have cultural significance to tribes are disturbed during onshore construction of the Proposed Action and reasonably foreseeable projects, the impact on these cultural resources would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. If construction of the Proposed Action and reasonably foreseeable projects is able to avoid these cultural resources, the impact on Native American tribes would be long term **negligible** to **minor** adverse.	**Onshore**: Construction and installation, O&M, and decommissioning of onshore facilities under Alternatives C through F would not be markedly different from the Proposed Action; therefore, impacts on environmental justice populations would be similar to the Proposed Action: long term **major** adverse if construction is unable to avoid cultural resources, and long term **negligible** to **minor** adverse if construction is able to avoid cultural resources. Likewise; cumulative impacts to environmental justice populations would be similar to the Proposed Action: long term **major** adverse if construction of the Proposed Action and reasonably foreseeable projects are unable to avoid cultural resources, and long term **negligible** to **minor** adverse if construction of the Proposed Action and reasonably foreseeable projects are able to avoid cultural resources.				**Onshore**: Construction and installation, O&M, and decommissioning of onshore facilities under Alternative G would not be markedly different from the Proposed Action; therefore, impacts on environmental justice populations would be similar to the Proposed Action: long term **major** adverse if construction is unable to avoid cultural resources, and long term **negligible** to **minor** adverse if construction is able to avoid cultural resources. Likewise; cumulative impacts to environmental justice populations would be similar to the Proposed Action: long term **major** adverse if construction of the Proposed Action and reasonably foreseeable projects are unable to avoid cultural resources, and long term **negligible** to **minor** adverse if construction of the Proposed Action and reasonably foreseeable projects are able to avoid cultural resources.
Noise	**Offshore**: Underwater noise from construction, O&M, and decommissioning activities related to offshore wind energy development could result in a decrease in the catch of some target species. Given that target	**Offshore**: Underwater noise from construction activities related to the Project could result in revenue reductions for commercial fishing and marine recreational businesses by decreasing the catch of some target species. Given that target species are expected to return to an area after the	**Offshore**: If certain WTG positions are omitted under Alternatives C through F, the adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations would be reduced. However, the noise impact level for commercial fisheries, for-hire recreational fishing, and recreational fishing would still be similar to the Proposed Action: short term **moderate** adverse during construction, and long term **moderate** adverse during O&M.				**Offshore**: If certain WTG positions are omitted under Alternative G, the adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations would be reduced. However, the noise impact level for

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	species are expected to return to an area after the noise ends, the adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **moderate**.	noise ends, the adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be short term **moderate** during construction, and long term **moderate** during O&M. The adverse economic effects of noise from ongoing and future offshore activities, including the Proposed Action, to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **moderate**.	Cumulatively, the impact to members of environmental justice populations employed in commercial and for-hire recreational fisheries or participating in recreational and subsistence fisheries would also be similar to that for the Proposed Action: long term **moderate** adverse.				commercial fisheries, for-hire recreational fishing, and recreational fishing would still be similar to the Proposed Action: short term **moderate** adverse during construction, and long term **moderate** adverse during O&M. Cumulatively, the impact to members of environmental justice populations employed in commercial and for-hire recreational fisheries or participating in recreational and subsistence fisheries would also be similar to that for the Proposed Action: long term **moderate** adverse.
	Onshore: Environmental justice populations near onshore facilities or ports used for construction staging could experience noise impacts. State and local agencies would be responsible for managing actions to help minimize and avoid noise impacts on nearby neighborhoods during construction. Therefore, offshore wind energy construction is expected to have short-term **minor** adverse noise impacts on environmental justice populations.	**Onshore**: Environmental justice populations near ports supporting Project construction or near the proposed landing site and onshore transmission cable route could experience noise impacts. Noise impacts to environmental justice populations near ports would be short term **negligible** to **minor** adverse and impacts during Project construction activities at the proposed landing site and along the onshore transmission cable route would be short term **minor** adverse. impacts to land uses from Project onshore facilities' O&M noise would be **negligible** adverse. Impacts during decommissioning would be similar to the impacts during construction and installation. Therefore, impacts to environmental justice populations would be long term **negligible** adverse during Project O&M, and short term **negligible** to **minor** adverse during decommissioning. The Proposed Action could increase exposure to noise pollution by environmental justice populations beyond conditions under the No Action Alternative. This would be a noticeable but minor adverse incremental impact and would cease when construction is complete. Therefore, when combined with past, present, and other reasonably foreseeable projects, the Project would have short-term **minor** adverse noise impacts on environmental justice populations.	**Onshore**: Construction and installation, O&M, and decommissioning of onshore facilities under Alternatives C through F would not be markedly different from the Proposed Action; therefore, impacts would be similar to the Proposed Action: short term to long term **negligible** to **minor** adverse on environmental justice populations near affected ports and near the proposed landing sites and onshore transmission cable route. Likewise, cumulative impacts to environmental justice populations would be similar to the Proposed Action: short term **minor** adverse.				**Onshore**: Construction and installation, O&M, and decommissioning of onshore facilities under Alternative G would not be markedly different from the Proposed Action; therefore, impacts would be similar to the Proposed Action: short term to long term **negligible** to **minor** adverse on environmental justice populations near affected ports and near the proposed landing sites and onshore transmission cable route. Likewise, cumulative impacts to environmental justice populations would be similar to the Proposed Action: short term **minor** adverse.
Presence of structures	**Offshore**: To the extent that the impacts of offshore structures result in declines in the economic performance of commercial fishing activities in which members of environmental justice populations are engaged, these	**Offshore**: To the extent that the impacts of offshore structures result in declines in the economic performance of commercial fishing activities in which members of environmental justice populations are engaged, these populations could be disproportionately adversely affected. However,	**Offshore**: If certain WTG positions are omitted under Alternatives C through F, the adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations would be reduced. However, the impact level from the presence of structures would be similar to the Proposed Action: short term to long term **negligible** to **moderate** adverse.				**Offshore**: If certain WTG positions are omitted under Alternative G, the adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations would be reduced. However, the impact level from the

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	populations could be disproportionately adversely affected. Impacts to environmental justice populations would be long term **negligible** to **major** adverse depending on the fishery and fishing operation. If BOEM's recommendations related to project siting, design, navigation, access, safety measures, and financial compensation are implemented across all offshore wind energy projects, adverse impacts on environmental justice population engaged in fisheries due to the presence of structures could be reduced. Offshore construction of WTG and OSS foundations could damage submerged ancient landforms that have cultural significance to Native American tribes in the GAA as part of ancient and ongoing tribal practices. If an ancient submerged landform is disturbed during offshore construction, the impact on the cultural resource would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. The adverse impact on Native American tribes would be long term **negligible** to **minor** if offshore wind energy project construction and installation, O&M, and decommissioning can avoid these cultural resources. The construction and presence of the offshore components could also result in modification to the existing viewshed during the daytime because a range of WTG structures would be visible on the horizon. Given the cultural significance of viewshed resources to Native American tribes, the visibility of these structures has the potential to adversely affect environmental justice populations. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic	adverse impacts to commercial and for-hire recreational fisheries would be reduced with EPMs. Therefore, the economic impacts of new cable emplacement and maintenance to environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be short term **negligible** to **moderate** adverse during construction and decommissioning and long term **negligible** to **moderate** adverse during operations. Members of environmental justice populations for whom subsistence fisheries are an important food source are not expected to lose access to fishing areas on the shoreline or close to shore during construction of the offshore RWEC and the Project's offshore components. Therefore, potential impacts to environmental justice populations from reduced subsistence fishing opportunities caused by dredging are considered long term but **negligible** adverse. Impacts to these individuals during Project O&M would be long term but **negligible** to **minor** adverse. Potential impacts from reduced subsistence fishing opportunities caused by dredging are expected to be long term but **negligible** adverse during Project O&M. The construction and presence of the offshore Project components would result in modification to the existing viewshed during the daytime because a range of RWF WTG structures would be visible on the horizon. Given the cultural significance of viewshed resources to Native American tribes, the visibility of these structures has the potential to adversely affect environmental justice populations. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects. The presence of structures impacts on submerged marine cultural resources from ongoing and future offshore activities, including the Project, could have long-term **major** adverse disproportionate impacts on Native American tribes if these cultural resources are disturbed. If the Proposed Action, together with ongoing and reasonably foreseeable activities, are able to avoid these cultural resources, the impact on Native American tribes would be long term **negligible** to **minor** adverse.	In addition, the omission of certain WTG positions could reduce impacts to submerged ancient landforms important to Native American tribes. However, the impact level from the presence of structures would be similar to the Proposed Action: long term **negligible** to **minor** adverse if construction and decommissioning are able to avoid cultural resources; long term **major** adverse if construction and decommissioning are unable to avoid cultural resources. Under Alternatives C through F, fewer WTG structures would be visible on the horizon from various shoreside historic properties of importance to Native American tribes. In particular, Alternative E is primarily focused on setbacks of WTGs from Martha's Vineyard and would effectively increase distances of Project WTG structures to viewshed resources important to Native American tribes at Aquinnah. However, the impact on environmental justice populations under Alternatives C through F would be similar to the Proposed Action. The impact level from the presence of structures of Alternatives C through F would not be markedly different from the Proposed Action. Therefore, the cumulative economic impacts on members of environmental justice populations employed in commercial and for-hire recreational fisheries would be similar to the Proposed Action: long term **moderate** to **major** adverse depending on the fishery and fishing operation. The cumulative impacts on Native American tribes that trace their ancestry to submerged marine cultural resources would be similar to the Proposed Action: long term **major** adverse if construction of the Proposed Action and reasonably foreseeable projects are unable to avoid cultural resources, and long term **negligible** to **minor** adverse if construction of the Proposed Action and reasonably foreseeable projects are able to avoid cultural resources.				presence of structures would be similar to the Proposed Action: short term to long term **negligible** to **moderate** adverse. In addition, the omission of certain WTG positions could reduce impacts to submerged ancient landforms important to Native American tribes. However, the impact level from the presence of structures would be similar to the Proposed Action: long term **negligible** to **minor** adverse if construction and decommissioning are able to avoid cultural resources and long term **major** adverse if construction and decommissioning are unable to avoid cultural resources. Under Alternative G, fewer WTG structures would be visible on the horizon from various shoreside historic properties of importance to Native American tribes. However, the impact on environmental justice populations under Alternative G would be similar to the Proposed Action. The impact level from the presence of structures under Alternative G would not be markedly different from the Proposed Action. Therefore, the cumulative economic impacts on members of environmental justice populations employed in commercial and for-hire recreational fisheries would be similar to the Proposed Action: long term **moderate** to **major** adverse depending on the fishery and fishing operation. The cumulative impacts on Native American tribes that trace their ancestry to submerged marine cultural resources would be similar to the Proposed Action: long term **major** adverse if construction of the Proposed Action and reasonably foreseeable projects are unable to avoid cultural resources, and long term **negligible** to **minor** adverse if construction of the Proposed Action and reasonably foreseeable projects are able to avoid cultural resources.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	properties, the adverse effects, and the resolution of adverse effects.	The cumulative economic impact to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing resulting from the presence of structures would be long term **moderate** to **major** adverse depending on the fishery and fishing operation.					
Vessel traffic	**Offshore**: Vessel traffic from construction, O&M, and decommissioning activities related to offshore wind energy development could result in revenue reductions for commercial fishing businesses that operate in the areas offshore from the GAA. Given that the potential for vessel congestion and gear conflict is expected to be long term, the adverse economic effects to members of environmental justice populations engaged in commercial fisheries would be long term **minor** to **moderate**.	**Offshore**: Vessel traffic from offshore activities related to Project construction, O&M, and decommissioning activities could result in revenue reductions for commercial fishing businesses that operate in the areas offshore from the GAA. Given that the potential for vessel congestion and gear conflict is expected to be long term, the economic effects to members of environmental justice populations engaged in commercial fisheries would be long term **minor** to **moderate** adverse**.** Vessel traffic from ongoing and future offshore activities, including the Proposed Action, is expected to continue. Therefore, the cumulative economic impacts to members of environmental justice populations engaged in commercial fisheries would be long term **minor** to **moderate** adverse.	**Offshore**: If certain WTG positions are omitted under Alternatives C through F, the adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations would be reduced. However, the vessel traffic impact level would still be similar to the Proposed Action: long term **minor** to **moderate** adverse. The vessel traffic impact of Alternatives C through F would not be markedly different from the Proposed Action. Therefore, the cumulative economic impacts on members of environmental justice populations employed in commercial fisheries would be similar to the Proposed Action: long term **minor** to **moderate** adverse.				**Offshore**: If certain WTG positions are omitted under Alternative G, the adverse impacts on commercial and for-hire recreational fisheries that provide employment for some members of environmental justice populations would be reduced. However, the vessel traffic impact level would still be similar to the Proposed Action: long term **minor** to **moderate** adverse. The vessel traffic impact of Alternative G would not be markedly different from the Proposed Action. Therefore, the cumulative economic impacts on members of environmental justice populations employed in commercial fisheries would be similar to the Proposed Action: long term **minor** to **moderate** adverse.
Vehicular traffic	**Onshore**: During construction of onshore facilities of future offshore wind energy development projects, neighboring or adjacent land to reasonably foreseeable projects could temporarily be disturbed by project–related vehicular traffic. State and local agencies would be responsible for managing actions to help minimize and avoid vehicular traffic impacts on nearby neighborhoods during construction. Therefore, environmental justice populations near onshore facilities or ports used for construction staging are expected to experience short-term **minor** adverse impacts during project construction and decommissioning activities and long-term **negligible** adverse impacts during project operations.	**Onshore**: Environmental justice populations near ports supporting Project construction or the proposed landing site and onshore transmission cable route could experience traffic impacts. Access to neighborhoods would be maintained, and activity and development from the Project would not occur at levels above those typically experienced or expected at these facilities and would not hinder other nearby land use. Therefore, impacts to environmental justice populations associated with vehicular traffic at ports during Project construction and decommissioning would be short term **minor** adverse. Construction of onshore facilities would temporarily disturb neighboring land uses through intermittent delays in travel along affected roads. State and local agencies would be responsible for managing actions to help minimize and avoid vehicular traffic impacts on nearby neighborhoods during construction. Therefore, impacts to the health and safety of environmental justice populations associated with vehicular traffic during Project construction and decommissioning activities at the proposed landing site and along the onshore	**Onshore**: Construction and installation and decommissioning of onshore facilities under Alternatives C through F would not be markedly different from the Proposed Action; therefore, impacts would be similar to the Proposed Action: short term **minor** adverse on environmental justice populations near affected ports and near the proposed landing sites and onshore transmission cable route. O&M of onshore facilities under Alternatives C through F would be long term **negligible** adverse. Likewise, cumulative impacts to the health and safety of environmental justice populations would be similar to the Proposed Action: short term **minor** adverse.				**Onshore**: Construction and installation and decommissioning of onshore facilities under Alternative G would not be markedly different from the Proposed Action; therefore, impacts would be similar to the Proposed Action: short term **minor** adverse on environmental justice populations near affected ports and near the proposed landing sites and onshore transmission cable route. Impacts from O&M of onshore facilities under Alternative G would be long term **negligible** adverse. Cumulative impacts to the health and safety of environmental justice populations would be similar to the Proposed Action: short term **minor** adverse.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
		transmission cable route would also be short term **minor** adverse. Traffic impacts to the health and safety of environmental justice populations near onshore facilities or ports used for construction staging during Project O&M would be **negligible** adverse. Traffic impacts to the health and safety of environmental justice populations associated with the Project, when combined with the impacts of past, present, and reasonably foreseeable future activities, would be short term **minor** adverse.					

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3.12.2.2 Alternative A: Impacts of the No Action Alternative on Environmental Justice

3.12.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for environmental justice (see Section 3.12.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the GAA. These IPFs are described and analyzed in Appendix E1

3.12.2.2.2 Cumulative Impacts

This section discloses potential environmental justice impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

Offshore Activities and Facilities

Air emissions: The largest emissions of regulated air pollutants would occur during construction of future offshore wind energy projects. Project air emissions from vessels, helicopters, generators, and fuel-burning equipment used during construction could have temporary **minor** to **moderate** adverse impacts on air quality, depending on the extent and duration of emissions (see Section 3.4). A large portion of the emissions would not be generated near populated areas but would be generated along the vessel transit routes and at the offshore work areas.

Members of environmental justice populations tend to be more burdened with adverse health conditions that can increase susceptibility to the harmful health effects of exposure to air environmental pollution (American Lung Association 2020). Consequently, the adverse impacts to air quality during project construction could result in short-term disproportionately high and adverse health and safety impacts to environmental justice populations near ports used for construction staging. The impacts would be greater if multiple offshore wind projects simultaneously use the same port for construction staging. If construction staging is distributed among several ports, the air emissions would not be concentrated near certain ports, and impacts on proximal environmental justice populations would be less.

During operations, offshore wind energy projects would reduce the need for fossil fuel–combusting power generation, which would have a net beneficial impact on air quality. The reduction in air emissions could produce measurable benefits in terms of lower health costs and loss of life (see Section 3.4). The susceptibility of environmental justice populations to the harmful health effects of air pollution includes exposure to fine particulate matter air pollution from fossil fuel–combusting power generation stations (EPA 2016b; Thind et al. 2019). Given that environmental justice populations tend to be more burdened with adverse health conditions that can increase susceptibility to the harmful effects of air pollution, the beneficial health impacts of reducing air pollution that accrues to these populations could be greater than those experienced by non-environmental justice populations who also reside in the affected area. Therefore, the air quality improvements from offshore wind energy development would have a long-term **minor** to **moderate** beneficial impact on the health and safety of environmental justice populations through a reduction or avoidance of air emissions and concomitant reduction or avoidance of adverse health impacts.

Climate change: Factors that make environmental justice populations particularly vulnerable to the adverse health, safety, and economic impacts of climate change–related events such as heatwaves, heavy flooding, and droughts include where they live, language barriers, their health, and their limited financial resources to cope with these effects (Cho 2020; EPA 2017). Future offshore wind energy project GHG emissions during construction would be short term **negligible** adverse as compared to aggregate global emissions. During O&M, these projects could beneficially contribute to a broader combination of actions to reduce future impacts from climate change trends over the long term (see Section 3.4). However, given the global scale of GHG emissions, the reduction in GHG emissions resulting from offshore wind energy development would have a long-term **negligible** beneficial impact on the health and safety of environmental justice populations.

Light: The view of nighttime aviation warning lighting required for offshore wind structures could have localized impacts on economic activity by affecting the decisions of tourists or visitors in selecting coastal locations to visit (see Section 3.18). To the extent that lighting for offshore wind structures has an adverse economic impact on tourism, environmental justice populations could be disproportionately affected. As described in Section 3.12.1, many of the workers in the service industries that support tourism are members of minority and/or low-income groups. The adverse economic effects of job losses for these workers could be especially severe because they have fewer financial resources to cope with the losses.

Visual impacts on recreation and tourism would be short term during construction and long term during O&M, with negligible to moderate adverse impacts, based on the observed distance and individual responses by recreationists and visitors to changes in the viewshed (see Section 3.18). Therefore, economic impacts to members of environmental justice populations employed in tourism-related service industries are expected to be short term **minor** to **moderate** adverse during construction and long term **minor** to **moderate** adverse during O&M. If ADLS (or a similar system) is installed on WTGs in other offshore wind energy projects, impacts to environmental justice populations would be reduced to **negligible** to **minor** adverse, as the amount of time WTGs would be visible at night would decrease (see Section 3.20).

Lighting on WTGs could also affect cultural resources (see Section 3.10), including views of the night sky and ocean that are important to Native American tribes. ADLS would reduce the impacts on Native American tribes associated with WTG lighting, but adverse impacts would continue. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects.

Light from construction, O&M, and decommissioning activities related to offshore wind energy development could result in revenue reductions for commercial fishing and for-hire recreational fishing businesses by decreasing the catch of some target species (see Section 3.9). Certain workers engaged in commercial fisheries and for-hire recreational fishing, such as fishing vessel deckhands and factory floor seafood processor workers, would be more vulnerable to job or income losses should Project construction disrupt fishing activities. As described in Section 3.12.1, many of these workers are members of minority and/or low-income groups. Given that adverse lighting impacts on target species catch in commercial and for-hire recreational fisheries are expected to be localized and short term (see Section 3.9), the adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be short term **minor** to **moderate**.

New cable emplacement/maintenance: As described in Section 3.10, cable emplacement resulting from future offshore wind energy development in the GAA could damage submerged ancient landforms that have cultural significance to Native American tribes as part of ancient and ongoing tribal practices. Disturbance and destruction of even a portion of an identified submerged landform could reduce or diminish the value of these resources as potential repositories of archaeological knowledge and cultural significance to tribes. BOEM and relevant State Historic Preservation Offices would require offshore wind energy projects to avoid known resources through the creation of avoidance buffers at ancient submerged landform features identified through geotechnical investigations. These measures would avoid or reduce impacts to marine cultural resources. However, in some cases, the number, extent, and dispersed character of these resources could make avoidance impossible. If an ancient, submerged landform is disturbed during offshore cable emplacement, the impact on the cultural resource would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. The impact on Native American tribes would be long term **negligible** to **minor** adverse if offshore wind energy project construction and installation, O&M, and decommissioning can avoid these cultural resources.

The economic impacts of new cable emplacement and maintenance to environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be similar to those discussed below under the presence of structures IPF. The potential impacts of both IPFs include loss of employment or income due to disruption to commercial fishing or for-hire recreational fishing businesses (see Section 3.9). Therefore, the new cable emplacement/maintenance impact level would be the same as the impact level from the presence of structures: long term **negligible** to **major** adverse depending on the fishery and fishing operation.

Noise: Underwater noise from construction, O&M, and decommissioning activities related to offshore wind energy development could result in revenue reductions for commercial fishing and marine recreational businesses by decreasing the catch of some target species (see Section 3.9). As described in Section 3.12.1, these businesses are a source of employment and income for minority and/or low-income workers. Given that target species are expected to return to an area after the noise ends (see Section 3.9), the adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **moderate**.

The localized adverse noise impacts of future offshore wind activities on fishing could affect low-income residents who substantially rely on recreational fisheries as a food source. Similarly, future offshore wind activities could have adverse impacts on the subsistence fisheries of Native American tribes in the GAA. However, typical recreational fishing locations in the area are close to shore (within 1 mile of the coast) (see Section 3.18). In addition, historically, much of the fishing by the region's Native American tribes was concentrated in the nearshore marine and estuarine environment (Bennett 1955). Recent BOEM consultation with Native American tribes in Lease Areas adjacent to the Project indicate that tribal subsistence fisheries continue to occur predominately in inshore areas (BOEM 2020). Consequently, future offshore wind energy projects are expected to have a long-term **negligible** to **minor** adverse impact on the recreational and subsistence fishing activities of environmental justice populations.

Presence of structures: An analysis of the impacts of installation of offshore wind energy structures, including WTGs and offshore submarine cables, to commercial fisheries and for-hire recreational fishing that could result from future offshore wind energy development is provided in Section 3.9. To the extent that the impacts of future offshore wind activities result in declines in the economic performance of commercial fisheries and for-hire recreational fisheries, members of environmental justice populations could be disproportionately affected. As described in Section 3.12.1, these fisheries are a source of employment and income for minority and/or low-income workers. As described in Section 3.9, for those fishing vessels that 1) derive a large percentage of their total revenue from areas where offshore wind facilities would be located, 2) choose to avoid these areas once the facilities become operational, and 3) are unable to find suitable alternative fishing locations, the adverse impacts of the presence of structures would be long term **major**. However, the number of such fishing businesses is expected to be small. WTG spacing and orientation measures, offshore cable burial, financial compensation programs for fishing interests, and other EPMs and BOEM-required mitigation measures implemented by offshore wind developers, together with the ability of fishing vessel operators to adjust transit and fishing locations to avoid conflicts with construction, O&M, and decommissioning activities related to offshore wind energy development, would help ensure that most of the commercial fishing and for-hire recreational fishing businesses could continue to operate with minimal disruption (see Section 3.9). Therefore, the adverse economic impacts to low-income and minority workers employed in fishing industry sectors, including harvesting, processing, and shoreside support services, would be long term **negligible** to **major** depending on the fishery and fishing operation.

As described in Section 3.10, offshore construction of WTG and OSS foundations could damage submerged ancient landforms that have cultural significance to Native American tribes in the GAA as part of ancient and ongoing tribal practices. Disturbance and destruction of even a portion of an identified submerged landform could reduce or diminish the value of these resources as potential repositories of archaeological knowledge and cultural significance to tribes. BOEM and relevant State Historic Preservation Offices would require offshore wind energy projects to avoid known resources through the creation of avoidance buffers at ancient, submerged landform features identified through geotechnical investigations. These measures would avoid or reduce impacts to marine cultural resources. However, in some cases, the number, extent, and dispersed character of these resources could make avoidance impossible. If an ancient submerged landform is disturbed during offshore construction, the impact on the cultural resource would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. The adverse impact on Native American tribes would be long term **negligible** to **minor** if offshore wind energy project construction and installation, O&M, and decommissioning can avoid these cultural resources.

The construction of the offshore components of offshore wind energy projects would modify the existing viewshed during the daytime because a number of WTG structures would be visible on the horizon (see Section 3.20). The presence of these structures could affect cultural resources (see Section 3.10), including views of the ocean from various shoreside historic properties of importance to Native American tribes. Given the cultural significance of viewshed resources to Native American tribes, the visibility of these structures could disproportionately adversely affect environmental justice populations. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects.

<u>Vessel traffic</u>: Vessel traffic from construction, O&M, and decommissioning activities related to offshore wind energy development could result in revenue reductions for commercial fishing businesses that operate in the areas offshore from the GAA (see Section 3.9). To the extent that the impacts of future offshore wind activities result in declines in the economic performance of commercial fisheries and for-hire recreational fisheries, members of environmental justice populations could be disproportionately

affected. As described in Section 3.12.1, these fisheries are a source of employment and income for minority and/or low-income workers. Given that the potential for vessel congestion and gear conflict is expected to be long term, the adverse economic effects to members of environmental justice populations engaged in commercial fisheries would be long term **minor** to **moderate**.

Onshore Activities and Facilities

Accidental releases and discharges: Onshore facilities of future offshore wind activities could affect water quality via accidental spills. See Section 3.21 and Section 3.14 for additional details. Potential impacts to water quality from equipment failure or mismanagement would only be anticipated if there are open bodies of water on or directly adjacent to future onshore facilities. Therefore, environmental justice populations in the GAA are expected to experience **negligible** adverse water quality impacts as a result of future offshore wind activities.

Air emissions: During construction of onshore facilities of future offshore wind energy projects, neighboring or adjacent land to reasonably foreseeable projects could temporarily be disturbed by project–related emissions and dust (see Section 3.14 and Section 3.4). State and local agencies would be responsible for managing actions to help minimize and avoid air quality impacts on nearby neighborhoods during construction. Therefore, the onshore activities associated with offshore wind energy construction are expected to have short-term **minor** to **moderate** adverse air quality impacts on the health and safety of environmental justice populations.

New cable emplacement/maintenance and presence of structures: As described in Section 3.10, activities associated with construction of the onshore components of future offshore wind energy projects, such as emplacement of onshore cables and new building construction, could physically disturb archaeological sites that have cultural significance to Native American tribes in the GAA as part of ancient and ongoing tribal practices. Although BOEM would be able to add terrestrial cultural resources identification requirements and mitigation measures for cables and structures associated with future offshore wind energy projects outside the current terrestrial APE, the potential for permanent, **minor** to **major** adverse impacts on buried cultural resources remains. If archaeological sites that have cultural significance to tribes are disturbed during onshore construction, the impact on these cultural resources would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. The adverse impact on Native American tribes would be long term **negligible** to **minor** if offshore wind energy project construction and installation, O&M, and decommissioning are able to avoid these cultural resources.

Noise: During construction of onshore facilities of future offshore wind energy development projects, neighboring or adjacent land to onshore construction areas and mustering port(s) of reasonably foreseeable projects could temporarily be disturbed by project-related noise (see Section 3.14). Onshore construction noise would temporarily inconvenience visitors, workers, and residents near sites where onshore cables, onshore substations, or port improvements are installed to support offshore wind.

Impacts would depend on 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. State and local agencies would be responsible for managing actions to help minimize and avoid noise impacts on nearby neighborhoods during construction. Noise generated by offshore wind energy project staging operations at ports could impact the health and safety of environmental justice populations if the port is located near such populations. The noise impacts from increased port utilization would be short term and variable, would be limited to the construction period, and would increase if a port is used for multiple offshore wind projects during the same time period. However, construction sounds specifically related to offshore wind energy project activities at port facilities are expected to be similar to operational sounds associated with routine activities at these ports. In addition, 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. Therefore, offshore wind energy construction is expected to have short-term **minor** adverse noise impacts on the health and safety of environmental justice populations.

Vehicular traffic: During construction of onshore facilities of future offshore wind energy development projects, neighboring or adjacent land to onshore construction areas and mustering port(s) of reasonably foreseeable projects could temporarily be disturbed by project–related vehicular traffic. See Section 3.14 for additional details. Environmental justice populations near onshore facilities could experience traffic impacts. State and local agencies would be responsible for managing actions to help minimize and avoid vehicular traffic impacts on nearby neighborhoods during construction. Environmental justice populations near ports used for construction staging could also experience traffic impacts. Project-related deliveries would result in trucks loading and unloading materials/equipment as well as vehicle movements to complete assembly, fabrication, and staging of project components and equipment. However, the projected traffic increase at ports is expected to be well within the daily fluctuation of ongoing port-related traffic. In addition, maintenance and protection of traffic setups may be implemented for offshore wind energy projects to minimize impacts to traffic. Therefore, offshore wind energy construction is expected to have short-term **minor** adverse vehicular traffic impacts on the health and safety of environmental justice populations during project construction and decommissioning activities and long-term **negligible** adverse impacts during project operations.

3.12.2.2.3 Conclusions

As discussed in Section 3.11, construction and installation, O&M, and decommissioning of offshore wind energy projects would support new employment and economic activity in the manufacturing sector and marine construction and transportation sectors. Some members of environmental justice populations are expected to experience these employment and income benefits, but the benefits would be no greater for environmental justice populations than those experienced by non-environmental justice populations residing in the GAA.

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on the health and safety of environmental justice populations associated with the Project would not occur.

Considering all the IPFs together, BOEM anticipates that the impacts to environmental justice populations associated with future offshore wind activities in the GAA would be short term during construction and long term during O&M, and **negligible** to **major** adverse. These ratings primarily reflect economic and public health and safety impacts to environmental justice populations due to increases in air emissions, noise, and traffic; decreases in water quality; job and income losses due to the disruption of commercial fisheries, for-hire recreational fishing, or the tourism industry; adverse impacts to subsistence fishing activities; visual impacts on resources culturally important to Native American tribes; and damage to submerged ancient landforms that have cultural significance to Native American tribes. Adverse impacts could be reduced or avoided with mitigation measures. In particular, the impact to Native American tribes due to future offshore wind activities in proximity to landforms and archaeological sites would change from long term **major** adverse to long term **negligible** to **minor** adverse if activities can avoid damage to these cultural resources. Long-term **negligible** to **moderate** beneficial effects to the health and safety of environmental justice populations could result from reductions in air pollution and GHG emissions if offshore wind replaces the need for fossil fuel–combusting power generation.

BOEM anticipates that future offshore wind activities in the GAA, combined with ongoing activities and reasonably foreseeable activities other than offshore wind, would result in an overall long-term **major** adverse impact to environmental justice populations due to climate change trends and disturbance of landforms and archaeological sites of cultural significance to Native American tribes. The impact to Native American tribes due to ongoing and future activities potentially affecting landforms and archaeological sites would be long term **negligible** to **minor** adverse if activities can avoid damage to these cultural resources.

3.12.2.3 Alternative B: Impacts of the Proposed Action on Environmental Justice

As discussed in Section 3.11, construction and installation, O&M, and decommissioning of the Proposed Action and all action alternatives considered in this EIS would support new employment and economic activity in the manufacturing sector and marine construction and transportation sectors. As a result, some members of environmental justice populations residing in the GAA are expected to experience employment and income benefits. Construction of the Project would be governed by the National Offshore Wind Agreement, which is a project labor agreement that would apply to domestic construction activities associated with the Project (VHB 2023). In addition, Revolution Wind is committing $1,000,000 to community-based programming, including $500,000 to the Community College of Rhode Island to help build their Global Wind Organization training center, and $500,000 to Building Futures Rhode Island to enable both new entrants to union construction careers (through pre-apprenticeship). An additional $700,000 will be dedicated to other local programming that creates access to these careers for disadvantaged communities (see Table F-1 in Appendix F).

In addition to supporting the employment described above, BOEM expects construction and installation, O&M, and decommissioning of the Project to affect environmental justice populations through the IPFs listed in the following section.

3.12.2.3.1 Construction and Installation

Offshore Activities and Facilities

<u>Air emissions</u>: As described in Section 3.4, during construction, Project air emissions from vessels, helicopters, generators, and fuel-burning equipment could have temporary, direct impacts on New London, Gloucester, Baltimore, Providence, Washington, Bristol, Norfolk, and Norfolk City Counties' air quality. However, potential emissions would be reduced by implementing proposed EPMs (see Table F-1 in Appendix F). Moreover, if the Project cannot demonstrate compliance with the NAAQS, a permit would not be issued and the Project would not proceed. Therefore, the adverse impacts to air quality near populated areas in the GAA during construction are expected to be short term **minor**, and the adverse impacts on the health and safety of environmental justice populations near mustering ports are expected to

be short term **minor** (Figures G-28 through G-33 in Appendix G show potential environmental justice areas of concern near ports).

Light: The Proposed Action would require nighttime construction vessel lighting similar to what is described in the No Action Alternative (see Section 3.12.1.1). To the extent that offshore lighting during Project construction has an adverse economic impact on tourism, environmental justice populations could be disproportionately affected because service industries that support tourism are a source of employment for low-income workers. Visual impacts on recreation and tourism would be short term with **negligible** to **moderate** adverse impacts, based on the observed distance and individual responses by recreationists and visitors to changes in the viewshed (see Section 3.18). Therefore, adverse economic impacts to members of environmental justice populations employed in tourism-related service industries are expected to be short term **negligible** to **moderate**.

Light from offshore activities related to Project construction could affect cultural resources (see Section 3.10), including views of the night sky and ocean that are important to Native American tribes. Given the cultural significance of viewshed resources to Native American tribes, this lighting has the potential to disproportionately adversely affect environmental justice populations. Revolution Wind has committed to implement ADLS as a measure to reduce light impacts (see Table F-1 in Appendix F). As a result, the adverse impacts of light from offshore activities on views important to Native American tribes would be reduced but not eliminated. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects.

The adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing during construction of the Project would be the same as described in the No Action Alternative (see Section 3.12.1.1): short term **minor** to **moderate**.

New cable emplacement/maintenance: Offshore cable emplacement during Project construction would be the same as described in the No Action Alternative (see Section 3.12.1.1) and could damage submerged ancient landforms. If these landforms are disturbed during construction of the Proposed Action, a long-term **moderate** to **major** adverse impact on the affected Native American tribes would result. If Project construction is able to avoid these cultural resources, the impact on Native American tribes would be long term **negligible** to **minor** adverse.

As noted in Section 3.9, some individual operators of commercial fishing or for-hire recreational fishing businesses could experience adverse economic impacts during construction of the RWEC and IAC. The economic impacts of new cable emplacement to environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be similar to those discussed below under the presence of structures IPF. The potential impacts of both IPFs include loss of employment or income due to disruption to commercial fishing or for-hire recreational fishing businesses (see Section 3.9), and during construction, these adverse economic impacts are expected to be short term **negligible** to **moderate**.

The closest shore-based fishing access site listed in the Marine Recreational Information Program website at NMFS (2022) to the cable landfall location is Compass Rose Beach near Quonset Point. Compass Rose Beach is approximately 2,600 feet east of the southeast corner of the landfall envelope. Given the distance from the cable landfall location and the use of HDD to reduce disturbance, impacts on any members of environmental justice populations residing in the area who fish for personal use or subsistence near the cable landfall would be short term negligible to minor. Therefore, the new cable emplacement and maintenance impact level would be the same as the impact level from the presence of structures: short term **minor** to **moderate** adverse.

Noise: The localized adverse noise impacts of offshore Project construction activities would be as described in Section 3.12.1.1. Consequently, noise generated by offshore activities during Project construction is expected to have a short-term **moderate** adverse impact on members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing.

Presence of structures: As noted in Section 3.9, some individual operators of commercial fishing or for-hire recreational fishing businesses could experience adverse economic impacts during Project construction as a result of the installation of WTGs and OSSs. Certain workers engaged in commercial fisheries and for-hire recreational fishing, such as fishing vessel deckhands and factory floor seafood processor workers, would be more vulnerable to job or income losses should Project construction disrupt fishing activities. Section 3.12.1 notes that many of these workers are members of minority and/or low-income groups. As described in Section 3.9, for those fishing vessels that 1) derive a large percentage of their total revenue from areas where offshore wind facilities would be located, 2) choose to avoid these areas once the facilities become operational, and 3) are unable to find suitable alternative fishing locations, the adverse impacts of the presence of structures would be long term **major**. However, the number of such fishing businesses is expected to be small. Revolution Wind's communication plans with the fishing industry and its financial compensation program for damage to or loss of fishing gear (Orsted U.S. Offshore Wind 2020) (see Table F-1 in Appendix F), together with the ability of many fishing vessel operators to adjust transit and fishing locations to avoid conflicts with construction activities, would help ensure that fishing businesses could continue to operate with minimal disruption (see Section 3.9). Therefore, adverse economic impacts to low-income and minority workers employed in fishing industry sectors, including harvesting, processing, and shoreside support services, would be short term **negligible** to **moderate**.

Members of environmental justice populations for whom subsistence fisheries are an important food source are not expected to lose access to fishing areas on the shoreline or close to shore during Project construction. As described in Section 3.18, construction staging areas would be located such that public parking, beach access, and access to campsites would be maintained. Additionally, Revolution Wind would inform all mariners, including commercial and recreational fishermen and recreational boaters, of construction activities and vessel movements (see Table F-1 in Appendix F). If the O&M facility is located in the Port of Montauk, initial construction dredging would occur under a separate offshore wind energy project (the SFWF Project). The Marine Recreational Information Program website at NMFS (2022) lists several publicly accessible fishing sites in Montauk that may be used for subsistence fishing by members of environment justice populations residing in the area. However, dredging in the Port of Montauk would occur only within a previously dredged footprint (Roll 2021). Moreover, the impact of this dredging on invertebrate and fish populations would be **negligible** adverse (see Section 3.6.2 and Section 3.13). Therefore, potential impacts to environmental justice populations from reduced subsistence fishing opportunities caused by dredging are considered long term **negligible** adverse.

Construction of the offshore Project components would result in modification to the existing viewshed during the daytime because a range of RWF WTG structures would be visible on the horizon (see Section

3.20). The presence of these structures could affect cultural resources (see Section 3.10), including views of the ocean from various shoreside historic properties of importance to Native American tribes. Given the cultural significance of viewshed resources to Native American tribes, the visibility of these structures has the potential to disproportionately adversely affect environmental justice populations. The visual impacts of the RWF WTGs would be moderated by their consistent structural appearances and color (see Sections 3.10 and 3.20). BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects.

Vessel traffic: Vessel traffic from Project construction would be the same as described in the No Action Alternative (see Section 3.12.1.1), and given that the potential for vessel congestion and gear conflict is expected to be short term (see Section 3.9), the adverse economic effects to members of environmental justice populations engaged in commercial fisheries would be short term **minor** to **moderate**.

Onshore Activities and Facilities

Accidental releases and discharges: Potential fuel or oil spills could occur during Project construction in or near concentrations of environmental justice populations. However, Table F-1 in Appendix F includes EPMs to avoid or reduce potential spill impacts on water quality. Moreover, there are no waterbodies in the path of the onshore transmission cable or on the OnSS or ICF parcels that could be contaminated by an accidental release and discharge resulting from equipment failure or mismanagement during construction (see Section 3.21). Therefore, impacts to the health and safety of environmental justice populations associated with changes in water quality during Project construction would be short term **negligible** adverse.

Air emissions: Environmental justice populations near the proposed landing sites and onshore transmission cable route could experience air quality impacts. Construction of the chosen landing site and onshore transmission cable route would temporarily disturb neighboring land uses through temporary increases in construction dust and emissions from heavy equipment performing clearing, grading, excavation, the installation of foundations, and heavy lifting of substation components. As described in Section 3.12.1, the block group in which most of the closest residences to the proposed onshore Project infrastructure are located is not a potential environmental justice area of concern based on either minority or low-income population criteria. Potential adverse air quality impacts from construction and diesel-generating equipment would be reduced through EPMs related to fuel-efficient engines and dust control plans (see Section 3.14). Therefore, impacts to the health and safety of environmental justice populations near the landing site and onshore transmission cable route associated with changes in air quality during Project construction would be short term **minor** adverse.

New cable emplacement/maintenance and presence of structures: Onshore cable emplacement during Project construction would be the same as described in the No Action Alternative (see Section 3.12.1.1) and could physically disturb archaeological sites. If archaeological sites that have cultural significance to tribes are disturbed during construction, the impact on these cultural resources would be permanent, resulting in a long-term **major** adverse impact on the affected Native American tribes. If Project construction is able to avoid these cultural resources, the impact on Native American tribes would be long term **negligible** to **minor** adverse.

The construction of the onshore Project components would result in modification to the existing viewshed because the OnSS and ICF infrastructure could be visible (see Section 3.20). The presence of these structures could affect cultural resources (see Section 3.10), including views from various shoreside historic properties of importance to Native American tribes. Given the cultural significance of viewshed resources to Native American tribes, the visibility of these structures has the potential to disproportionately adversely affect environmental justice populations. However, the OnSS and ICF infrastructure would largely blend with the existing Quonset Point Naval Air Station, and the presence of existing intervening residential development and landscape vegetation along roadways and other viewing locations would further reduce the extent of visual impacts (see Section 3.10 and Section 3.20). BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects.

Noise: Environmental justice populations near mustering ports that support Project construction could experience noise impacts (Figures G-28 through G-33 in Appendix G show potential environmental justice areas of concern near ports). However, the ports under consideration for construction staging are industrial in character, designated by local zoning and land use plans for heavy industrial activity, and typically adjacent to other industrial or commercial land uses and major transportation corridors. Noise levels are not expected to exceed ambient noise conditions generated by ongoing port activities (see Section 3.14). Therefore, noise impacts to the health and safety of environmental justice populations near ports would be short term **negligible** to **minor** adverse.

Environmental justice populations near the proposed landing site and onshore transmission cable route could also experience noise impacts. The landfall work area at Quonset Point in North Kingstown, Rhode Island, has been developed for industrial use, and the noise from Project construction would not be out of context with a working industrial park (see Section 3.14). The block group in which most of the closest residences to the proposed onshore Project infrastructure are located is not a potential environmental justice area of concern based on either minority or low-income population criteria. Noise generated by Project construction and installation activities is expected to comply with the Town of North Kingstown noise code (see Section 3.14). Additionally, the onshore construction schedule would be designed to minimize impacts to the local community during the summer tourist season (see Table F-1 in Appendix F), thereby reducing the economic impact on members of environmental justice populations employed in service industries that support tourism. Therefore, impacts to the health and safety of environmental justice populations associated with noise during Project construction activities at the proposed landing site and along the onshore transmission cable route would be short term **minor** adverse.

Vehicular traffic: Environmental justice populations near mustering ports that support Project construction could experience traffic impacts (Figures G-28 through G-33 in Appendix G show potential environmental justice areas of concern near ports). Access to neighborhoods would be maintained, and activity and development from the Project would not occur at levels above those typically experienced or expected at these facilities and would not hinder other nearby land use (see Section 3.14). Moreover, maintenance and protection of traffic setups would be implemented to minimize impacts to traffic during Project construction (VHB 2023). Therefore, adverse impacts to the health and safety of environmental justice populations associated with vehicular traffic at ports during Project construction would be short term **minor**.

Environmental justice populations near the proposed landing site and onshore transmission cable route could also experience traffic impacts. Construction of these onshore facilities would temporarily disturb neighboring land uses through intermittent delays in travel along affected roads (see Section 3.14). The block group in which most of the closest residences to the proposed onshore Project infrastructure are located is not a potential environmental justice area of concern based on either minority or low-income population criteria. Revolution Wind would abide by local construction ordinances and would work with the Town of North Kingstown to develop a detailed plan that includes traffic and other control measures prior to beginning major construction. The traffic plan with North Kingstown would identify appropriate alternative routes that would accommodate projected traffic loading during construction activities (see Section 3.14). Additionally, the onshore construction schedule would be designed to minimize traffic impacts to the local community during the summer tourist season (see Table F-1 in Appendix F), thereby reducing the economic impact on members of environmental justice populations employed in service industries that support tourism. Therefore, impacts to the health and safety of environmental justice populations associated with vehicular traffic during Project construction activities at the proposed landing site and along the onshore transmission cable route would be short term **minor** to **moderate** adverse.

3.12.2.3.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Air emissions: During operations, the Project would have an overall long-term **minor** beneficial health impact on populations in the GAA, including environmental justice populations, by avoiding a portion of the air pollutant emissions generated by fossil fuel–combusting energy facilities (see Section 3.4). Given that environmental justice populations tend to be more burdened with adverse health conditions that can increase susceptibility to the harmful effects of air pollution, the beneficial health impacts of reducing air pollution that accrue to these populations could be greater than those experienced by non-environmental justice populations who also reside in the affected area. Impacts during Project decommissioning would be similar to impacts during construction: short term **minor** adverse. There would be no further impacts once decommissioning is complete.

Climate change: Given that environmental justice populations could be particularly vulnerable to the adverse impacts of climate change trends because of where they live, language barriers, their health, and their limited financial resources to cope with these effects, the beneficial impacts of reducing GHG emissions that accrue to these populations could be greater than those experienced by non-environmental justice populations who also reside in the affected area. During operations, the Project would contribute to a broader combination of actions to reduce future impacts from climate change trends over the long term (see Section 3.4). However, given the global scale of GHG emissions, the reduction in GHG emissions resulting from the Project would have a long-term **negligible** beneficial impact on the health and safety of environmental justice populations.

Light: The view of nighttime aviation warning lighting required for O&M of offshore Project facilities is the same as described in the No Action Alternative (see Section 3.12.1.1). However, Revolution Wind has committed to implement ADLS as a measure to reduce light impacts (see Table F-1 in Appendix F), and visual impacts on recreation and tourism during O&M, while long term, are expected to be **negligible** adverse (see Section 3.18). Therefore, adverse economic impacts to members of environmental justice populations employed in tourism-related service industries are expected to be long term **negligible** adverse. Impacts during Project decommissioning would be similar to impacts during construction: short term **negligible** to **moderate** adverse. There would be no further impacts once decommissioning is complete.

Lighting on WTGs could also affect cultural resources (see Section 3.10) during O&M, including views of the night sky and the ocean that are important to Native American tribes. ADLS would reduce the impacts on Native American tribes associated with WTG lighting, but adverse impacts would continue. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects. Impacts during Project decommissioning would be similar to impacts during construction. There would be no further impacts once decommissioning is complete.

Light from O&M activities related to the Project could result in revenue reductions for commercial fishing and for-hire recreational fishing businesses by decreasing the catch of some target species as described in the No Action Alternative (see Section 3.12.1.1). Given that adverse lighting impacts on target species' catch in commercial and for-hire recreational fisheries are expected to be localized and long term, the adverse economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **minor** to **moderate**. Impacts during Project decommissioning would be similar to impacts during construction: short term **minor** to **moderate** adverse. There would be no further impacts once decommissioning is complete.

<u>New cable emplacement/maintenance</u>: As described in Section 3.10, Project O&M activities in the Lease Area and along the offshore RWEC could impact unknown submerged marine cultural resources of importance to Native American tribes. However, Revolution Wind could conduct O&M activities on equipment in areas that previously experienced disturbance during construction, thereby reducing impacts to submerged marine cultural resources to long term **negligible** adverse. Therefore, adverse impacts to Native American tribes due to potential disturbance of these cultural resources are expected to be long term **negligible**. Impacts during Project decommissioning would be similar to impacts during construction: long term **negligible** to **minor** adverse if Project decommissioning is able to avoid these cultural resources. There would be no further impacts once decommissioning is complete.

As noted in Section 3.9, some individual operators of commercial fishing or for-hire recreational fishing businesses could experience adverse economic impacts during maintenance of the RWEC and IAC. The adverse impacts of cable maintenance to environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be similar to those discussed below under the presence of structures IPF. The potential impacts of both IPFs include loss of employment or income due to disruption to commercial fishing or for-hire recreational fishing businesses (see Section 3.9), and during O&M, these adverse economic impacts are expected to be long term **negligible** to **moderate**. Impacts during Project decommissioning would be similar to impacts during construction: short term **moderate** adverse. There would be no further impacts once decommissioning is complete.

<u>Noise</u>: The localized adverse noise impacts of offshore Project O&M activities would be as described in Section 3.12.1.1. Consequently, noise generated by offshore activities during Project O&M is expected to have a long-term **moderate** adverse impact on members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing.

Presence of structures: As noted in Section 3.9, some individual operators of commercial fishing or for-hire recreational fishing businesses could experience adverse economic impacts during Project O&M as a result of the presence of WTGs and OSSs. Certain workers engaged in commercial fisheries and for-hire recreational fishing, such as fishing vessel deckhands and factory floor seafood processor workers, could be more vulnerable to job or income losses should Project O&M disrupt fishing activities. Section 3.12.1 notes that many of these workers are members of minority and/or low-income populations. As described in Section 3.9, for those fishing vessels that 1) derive a large percentage of their total revenue from areas where offshore wind facilities would be located, 2) choose to avoid these areas once the facilities become operational, and 3) are unable to find suitable alternative fishing locations, the adverse impacts of the presence of structures would be long term **major**. However, the number of such fishing businesses is expected to be small. Revolution Wind's communication plans with the fishing industry and its financial compensation program for damage to or loss of fishing gear (Orsted U.S. Offshore Wind 2020), together with the ability of many fishing vessel operators to adjust transit and fishing locations to avoid conflicts with operation activities, would help ensure that fishing businesses could continue to operate with minimal disruption (see Section 3.9). Therefore, the adverse economic impacts to low-income and minority workers employed in fishing industry sectors, including harvesting, processing, and shoreside support services, would be long term **negligible** to **moderate** during Project O&M. Impacts during Project decommissioning would be similar to impacts during construction: short term **negligible** to **moderate** adverse. There would be no further impacts once decommissioning is complete.

As described in Section 3.12.1.1, members of environmental justice populations for whom subsistence fisheries are an important food source generally fish close to shore and are not likely to travel and fish within the Lease Area. Therefore, impacts to these individuals during Project O&M would be long term **negligible** to **minor** adverse. If the O&M facility is located in the Port of Montauk, then maintenance dredging would occur, but only within a previously dredged footprint. The impact of this dredging on invertebrate and fish populations would be long term **negligible** adverse (see Section 3.6 and Section 3.13). Therefore, potential impacts to environmental justice populations from reduced subsistence fishing opportunities caused by dredging are expected to be long term **negligible** adverse.

As discussed above, during the daytime, the range of RWF WTG structures would be visible on the horizon from various shoreside historic properties of importance to Native American tribes. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects, and the resolution of adverse effects.

Vessel traffic: Vessel traffic from offshore activities related to Project O&M could result in revenue reductions for commercial fishing businesses that operate in the areas offshore from the GAA (see Section 3.9). To the extent that the impacts of future offshore wind activities result in declines in the economic performance of commercial fisheries and for-hire recreational fisheries, members of environmental justice populations could be disproportionately affected. As described in Section 3.12.1, these fisheries are a source of employment and income for minority and/or low-income workers. Given that the potential for vessel congestion and gear conflict is expected to be long term, the economic effects to members of environmental justice populations engaged in commercial fisheries would be long term **minor** to **moderate** adverse. Impacts during Project decommissioning would be similar to impacts during construction: short term **minor** to **moderate** adverse. There would be no further impacts once decommissioning is complete.

Onshore Activities and Facilities

Accidental releases and discharges: As described in Section 3.21, Project O&M and decommissioning would include the same permit requirements and controls as described for construction activities and would lead to the same **negligible** adverse impacts to water quality. Therefore, adverse water quality impacts to the health and safety of environmental justice populations would be short term **negligible** adverse during Project O&M and short term **negligible** adverse during decommissioning. There would be no further impacts once decommissioning is complete.

Air emissions: As described in Section 3.4, impacts to air quality from Project onshore facilities' O&M emissions would be **negligible** to **minor** adverse. Impacts during decommissioning would be similar to the impacts during construction and installation. Therefore, impacts to the health and safety of environmental justice populations would be long term **negligible** to **minor** adverse during Project O&M and short term **minor** adverse during decommissioning. There would be no further impacts once decommissioning is complete.

Noise: As described in Section 3.14, impacts to land uses from Project onshore facilities' O&M noise would be **negligible** adverse. Impacts during decommissioning would be similar to the impacts during construction and installation. Therefore, impacts to the health and safety of environmental justice populations would be long term **negligible** adverse during Project O&M and short term **negligible** to **minor** adverse during decommissioning. There would be no further impacts once decommissioning is complete.

Vehicular traffic: As described in Section 3.14, traffic impacts to land uses during Project O&M would be **negligible** adverse. Impacts during decommissioning would be similar to the impacts during construction and installation. Therefore, impacts to the health and safety of environmental justice populations would be long term **negligible** adverse during Project O&M and short term **minor** adverse during decommissioning. There would be no further impacts once decommissioning is complete.

3.12.2.3.3 Cumulative Impacts

Offshore Activities and Facilities

Air emissions: Despite the potential for increased air emissions during construction of the Project and other new offshore wind energy projects, over the long term the reduction in the need for fossil fuel–combusting power generation would have a net beneficial impact on air quality in the GAA (see Section 3.4). Members of environmental justice populations tend to be more burdened with adverse health conditions that can increase susceptibility to the harmful health effects of exposure to environmental pollution, including the fine particulate matter air pollution from fossil fuel–combusting power plants). Therefore, the air quality improvements from offshore wind energy development would have a long-term **minor** to **moderate** beneficial cumulative impact on the health and safety of environmental justice populations.

Climate change: The frequency and intensity of climate-related events such as heat waves and heavy flooding are becoming more frequent and more intense across most land regions, and this trend is expected to continue (IPCC 2021). Factors that make environmental justice populations particularly vulnerable to the adverse health, safety, and economic impacts of climate change–related events such as heat waves, heavy flooding, and droughts include where they live, language barriers, their health, and their limited financial resources to cope with these effects. Therefore, the adverse impacts to the health and safety of environmental justice populations of GHG emissions from ongoing and future offshore activities and facilities could be greater than those experienced by non-environmental justice populations who also reside in the affected area. The Proposed Action, together with other future offshore wind energy projects, could beneficially contribute to a broader combination of actions to reduce future impacts from climate change trends over the long term. However, given the global scale of GHG emissions, environmental justice populations in the affected area are expected to experience adverse cumulative impacts from climate change trends that are long term **major**.

Light: Aviation hazard lighting from 876 WTGs associated with the No Action Alternative and Proposed Action within the recreation and tourism GAA could be visible from coastal locations. The view of this lighting could have localized impacts on economic activity by affecting the decisions of tourists or visitors in selecting coastal locations to visit (see Section 3.18). To the extent that the lighting has an adverse economic impact on tourism, environmental justice populations could be disproportionately affected because service industries that support tourism are a source of employment for low-income workers. The use of ADLS would reduce impacts to tourism, thereby reducing the cumulative economic impact of lighting to environmental justice populations to long term **negligible** adverse.

Cumulatively, the Proposed Action when combined with ongoing and reasonably foreseeable activities could have adverse impacts on viewshed resources (see Section 3.10), including views of the night sky and ocean that are important to Native American tribes. ADLS would reduce the impacts on Native American tribes associated with WTG lighting but adverse impacts would continue. BOEM remains in consultation with Native American tribes and NHPA Section 106 consulting parties regarding identified historic properties, the adverse effects of offshore wind energy development, and the resolution of these adverse effects.

Ongoing and future offshore activities, including the Proposed Action, that introduce artificial lighting could result in revenue reductions for commercial fishing and for-hire recreational fishing businesses by decreasing the catch of some target species. Certain workers engaged in commercial fisheries and for-hire recreational fishing, such as fishing vessel deckhands and factory floor seafood processor workers, would be more vulnerable to job or income losses should Project construction disrupt fishing activities. As described in Section 3.12.1, many of these workers are members of minority and/or low-income groups. Given that adverse lighting impacts on target species catch in commercial and for-hire recreational fisheries are expected to be localized and short term (see Section 3.9), the cumulative economic impacts to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **minor** to **moderate** adverse.

New cable emplacement/maintenance: The cable emplacement impacts on submerged marine cultural resources from ongoing and future offshore activities, including the Project, could have disproportionate adverse impacts on Native American tribes that trace their ancestry to these resources. The Project and other proposed offshore wind energy projects are expected to implement plans to avoid and minimize impacts on submerged marine cultural resources. However, ancient submerged landforms could extend beyond the maximum work area or Lease Area for an undertaking; for this reason, it may not be practicable to avoid these features through Project redesign. Disturbance and destruction of even a portion of an identified submerged landform could reduce or diminish the value of the resource as a potential repository of archaeological knowledge and cultural significance to tribes. Therefore, the Proposed Action when combined with ongoing and reasonably foreseeable activities could result in long-term **major** adverse cumulative impacts to affected Native American tribes.

To the extent that Project impacts, together with the impacts of ongoing and other future offshore activities, result in declines in the economic performance of commercial and for-hire recreational fisheries, members of environmental justice populations could be disproportionately affected. Certain workers engaged in commercial fisheries and for-hire recreational fishing, such as fishing vessel deckhands and factory floor seafood processor workers, would be more vulnerable to job or income losses should Project construction disrupt fishing activities. As described in Section 3.12.1, many of these workers are members of minority and/or low-income groups. Therefore, the Proposed Action when combined with ongoing and reasonably foreseeable activities could result in long-term **moderate** to **major** adverse impacts depending on the fishery and fishing operation. Financial compensation policies implemented by offshore wind developers, together with the ability of some fishing vessel operators to adjust transit and fishing locations to avoid conflicts with construction and installation, O&M, and decommissioning activities related to offshore wind energy development, would help ensure that fishing businesses could continue to operate with minimal disruption.

Noise: Ongoing and future offshore activities, including the Proposed Action, that increase underwater noise could result in revenue reductions for commercial fishing and marine recreational businesses by decreasing the catch of some target species. As described in Section 3.12.1, these businesses are a source of employment and income for minority and/or low-income workers. Given that target species are expected to return to an area after the noise ends, the cumulative economic effects to members of environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be long term **moderate** adverse.

The localized adverse noise impacts of ongoing and future offshore activities on fishing could affect low-income residents who substantially rely on recreational fisheries as a food source. Similarly, offshore noise could have adverse impacts on the subsistence fisheries of Native American tribes in the GAA. However, as described in Section 3.12.1.1, local recreational and subsistence fisheries occur predominately in inshore areas. Consequently, ongoing and future offshore activities are expected to have a long-term **negligible** to **minor** adverse cumulative impact on the recreational and subsistence fishing activities of environmental justice populations.

Presence of structures: The cumulative economic impacts of offshore structures to environmental justice populations engaged in commercial fisheries and for-hire recreational fishing would be similar to the cumulative impacts of new cable emplacement and maintenance. The potential impacts of both IPFs include loss of employment or income due to disruption to commercial fishing or for-hire recreational fishing businesses. Therefore, the cumulative impact level from the presence of structures would be the same as the cumulative new cable emplacement and maintenance impact level: long term **moderate** to **major** adverse depending on the fishery and fishing operation. Financial compensation policies implemented by offshore wind developers, together with the ability of some fishing vessel operators to adjust transit and fishing locations to avoid conflicts with construction and installation, O&M, and decommissioning activities related to offshore wind energy development, would help ensure that fishing businesses could continue to operate with minimal disruption.

The cumulative impacts of the construction of offshore structures on submerged marine cultural resources from ongoing and future offshore activities, including the Project, could have long-term **major** disproportionate adverse impacts on Native American tribes that trace their ancestry to these resources. The Project and other proposed wind energy projects are expected to implement plans to avoid and minimize impacts on submerged marine cultural resources. However, ancient submerged landforms could extend well beyond the maximum work area or lease block for an undertaking; for this reason, it may not be practicable to avoid these features through Project redesign.

Vessel traffic: Vessel traffic from ongoing and future offshore activities, including the Proposed Action, is expected to continue. Given that the potential for vessel congestion and gear conflict is expected to be long term, the cumulative economic effects to members of environmental justice populations engaged in commercial fisheries would be long term **minor** to **moderate** adverse.

Onshore Activities and Facilities

Accidental releases and discharges: The Proposed Action is not expected to increase adverse water quality impacts on the health and safety of environmental justice populations beyond conditions under the No Action Alternative. See Section 3.21 and Section 3.14 for additional details regarding water quality impacts. To the extent that decreases in water quality occur as a result of ongoing and future onshore activities, environmental justice populations could experience adverse environmental and health effects. However, it is expected that onshore and offshore development, including the Proposed Action, would comply with all regulatory requirements for water quality protection. Therefore, when combined with past, present, and other reasonably foreseeable projects, the Project would have short term **negligible** to **minor** cumulative adverse water quality impacts on the health and safety of environmental justice populations.

Air emissions: While air emissions in the region would increase temporarily during construction of offshore wind energy projects, including the Proposed Action, the operation of these projects could contribute to a long-term cumulative net decrease in emissions by substituting some existing fossil fuel sources with a renewable source (see Section 3.4). Therefore, past, present, and other reasonably foreseeable projects are expected to have long-term **minor** to **moderate** beneficial impacts on the health and safety of environmental justice populations.

New cable emplacement/maintenance and presence of structures: As described in Section 3.10, activities associated with construction of the onshore components of the Proposed Action and reasonably foreseeable projects, such as emplacement of onshore cables and new building construction, could physically disturb archaeological sites that have cultural significance to Native American tribes in the GAA as part of ancient and ongoing tribal practices. If archaeological sites that have cultural significance to tribes are disturbed during onshore construction, the impact on these cultural resources would be permanent, resulting in a long-term **major** adverse cumulative impact on the affected Native American tribes. If construction of the Proposed Action and reasonably foreseeable projects is able to avoid these cultural resources, the cumulative impact on Native American tribes would be long term **negligible** to **minor** adverse.

Noise: The Proposed Action could increase exposure to noise pollution by environmental justice populations beyond conditions under the No Action Alternative. This would be a noticeable but minor adverse incremental impact and would cease when construction is complete (see Section 3.14). To the extent that increases in noise pollution occur as a result of ongoing and future onshore activities, environmental justice populations could experience adverse environmental and health effects. State and local agencies would be responsible for minimizing and avoiding noise and air quality impacts on nearby neighborhoods, including those neighborhoods in which environmental justice populations reside. Therefore, when combined with past, present, and other reasonably foreseeable projects, the Project would have short-term **minor** adverse cumulative noise impacts on the health and safety of environmental justice populations.

Vehicular traffic: The Proposed Action could result in intermittent delays in travel along impacted roads during the construction and installation phase. This would be a noticeable but minor adverse incremental impact and would cease when construction is complete (see Section 3.14). To the extent that increases in vehicular traffic occur as a result of ongoing and future onshore activities, environmental justice populations could experience adverse environmental and health effects. State and local agencies would be responsible for minimizing and avoiding traffic impacts on nearby neighborhoods, including those neighborhoods in which environmental justice populations reside. Therefore, cumulative traffic impacts to environmental justice populations associated with the Project, when combined with the impacts of past, present, and reasonably foreseeable future activities, would be short term **minor** adverse.

3.12.2.3.4 Conclusions

Project construction and installation, O&M, and decommissioning would have short-term to long-term adverse impacts on environmental justice populations, primarily through economic and public health and safety impacts associated with increases in air emissions, noise, and traffic; decreases in water quality; job and income losses due to the disruption of commercial fisheries, for-hire recreational fishing, or the tourism industry; adverse impacts to subsistence fishing activities; visual impacts on resources culturally important to Native American tribes; and damage to submerged ancient landforms that have cultural significance to Native American tribes. BOEM expects the overall level of impacts to environmental justice populations from the Proposed Action alone due to these factors to be **minor** to **moderate** adverse, as impacts could be reduced or avoided with EPMs. In addition, long-term **negligible** to **moderate** beneficial effects to the health and safety of environmental justice populations could result from reductions in air pollution and GHG emissions to the extent that the Project replaces the need for fossil fuel–combusting power generation.

Considering all the IPFs together, BOEM anticipates that the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in an overall long-term **major** adverse impact to environmental justice populations due to climate change trends and disturbance of landforms and archaeological sites of cultural significance to Native American tribes. The impact to Native American tribes due to ongoing and future activities potentially affecting landforms and archaeological sites would be long term **negligible** to **moderate** adverse if activities can avoid damage to these cultural resources.

3.12.2.4 Alternatives C, D, E, and F

Table 3.12-4 provides a summary of IPF findings for these alternatives.

3.12.2.4.1 Conclusions

If some WTGs are omitted under Alternatives C through F, a number of adverse impacts could be diminished relative to the Proposed Action. In particular, there could be a reduction in job and income losses due to the disruption of commercial fisheries, for-hire recreational fishing, or the tourism industry; a reduction in visual impacts on resources culturally important to Native American tribes; and a reduction in damage to submerged ancient landforms that have cultural significance to Native American tribes. However, BOEM expects the overall level of impact to environmental justice populations resulting from each alternative alone would be similar to that of the Proposed Action: long term **minor** to **moderate** adverse and long-term **negligible** to **moderate** beneficial. In the context of other reasonably foreseeable environmental trends and planned actions, BOEM also expects that Alternatives C through F's incremental impacts to environmental justice populations would be similar to the Proposed Action. Therefore, the overall impacts of Alternatives C through F when combined with past, present, and reasonably foreseeable activities would be the same as under the Proposed Action: long term **major** adverse due to climate change trends and disturbance of landforms and of archaeological sites of cultural significance to Native American tribes.

3.12.2.5 Alternative G: Impacts of the Preferred Alternative on Environmental Justice

Table 3.12-4 provides a summary of IPF findings for this alternative.

3.12.2.5.1 Conclusions

If some WTGs are omitted under Alternative G, a number of adverse impacts could be diminished relative to the Proposed Action. In particular, there could be a reduction in job and income losses due to 1) the disruption of commercial fisheries, for-hire recreational fishing, or the tourism industry and 2) a reduction in visual impacts on resources culturally important to Native American tribes. However, BOEM expects the overall level of impact to environmental justice populations resulting from each alternative alone would be similar to the Proposed Action: long term **minor** to **moderate** adverse and long-term **negligible** to **moderate** beneficial.

In the context of other reasonably foreseeable environmental trends and planned actions, BOEM also expects that Alternative G's incremental impacts to environmental justice populations would be similar to the Proposed Action. Therefore, the overall impacts of Alternative G when combined with past, present, and reasonably foreseeable activities would be the same as under the Proposed Action: long term **major** adverse due to climate change trends and disturbance of landforms and of archaeological sites of cultural significance to Native American tribes.

3.12.2.6 Mitigation

Additional mitigation measures identified by BOEM and cooperating agencies with the potential to reduce impacts to environmental justice populations are provided in Table F-3 in Appendix F and addressed in Table 3.12-5. Table F-3 also lists potential additional mitigation measures identified under other resource areas that could affect environmental justice populations in the areas of benthic habitat and invertebrates, finfish and EFH, commercial and for-hire recreational fishing, cultural resources, marine mammals, navigation and vessel traffic, and recreation and tourism.

Table 3.12-5. Additional Mitigation and Monitoring Measures for Environmental Justice (Appendix F, Table F-3)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Environmental data sharing with federally recognized tribes	No later than 90 days after COP approval, Revolution Wind must, at a minimum, contact the federally recognized tribes currently consulting on the Project to solicit their interest in receiving access to the following: Reports generated as a result of the fisheries and benthic monitoring plan Reporting of all NARW sightings Reporting of all injured or dead protected species (turtles and NARW) NARW passive acoustic monitoring PSO reports (e.g., weekly pile-driving reports) Pile-driving schedule and changes thereto At a minimum, Revolution Wind should offer access to the following federally recognized tribes: Delaware Nation, Delaware Tribe of Indians, Mashantucket (Western) Pequot Tribal Nation, Mashpee Wampanoag Tribe, Mohegan Tribe of Connecticut, Narragansett Indian Tribe, Shinnecock Indian Nation, Wampanoag Tribe of Gay Head (Aquinnah). Revolution Wind must provide access to non-proprietary/non-confidential business information to the federally recognized tribes no later than 30 days after the information becomes available.	This measure would not modify the impact determinations for environmental justice; however, the data shared with tribes would keep them informed of activities and impacts occurring in the analysis area.
Environmental justice outreach planning	In areas where environmental justice communities experience direct impacts from onshore construction activities relating to onshore cable emplacement and installation of OnSS and ICF infrastructure, Revolution Wind shall establish outreach with local communities to provide opportunities for community residents and local authorities to engage with Revolution Wind on Project activities. This engagement may be partially fulfilled through Revolution Wind's planned coordination with local authorities during construction of onshore facilities to minimize local traffic impacts (see EPM EJ-3 in Table F-1, Appendix F). As applicable, this engagement may also be partially fulfilled by enhanced stakeholder outreach conducted to meet requirements identified in RIDEM's regulations and policies regarding Environmental Justice Focus Areas related to investigation and remediation of contaminated soil and groundwater (see EPM EJ-4 in Table F-1, Appendix F). Revolution Wind shall offer additional	This measure would not modify the impact determinations for environmental justice; however, outreach to local environmental justice communities would keep them informed of activities and impacts occurring in the analysis area and would inform BOEM of any ongoing concerns.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	engagement opportunities, in coordination with applicable local and state authorities, in a timely and locally appropriate manner, including translation into non-English languages as appropriate.	

3.12.2.6.1 Mitigation Measures Incorporated into the Preferred Alternative

BOEM has identified the following additional mitigation measures listed above in Table 3.12-5, and also found in Table F-3 in Appendix F, as incorporated into Alternative G (Preferred Alternative): environmental data sharing with federally recognized tribes and environmental justice outreach planning. Although these measures, if adopted, would not modify the impact determinations on environmental justice populations, they would facilitate the dissemination of Project information to those populations and would support engagement with communities with environmental justice concerns, which is an important element of addressing environmental justice. Such measures could help establish dialogue between potentially impacted environmental justice populations and Revolution Wind, and the reporting component of the outreach planning measure would inform BOEM of any concerns raised by members of environmental justice populations during onshore construction.

3.13 Finfish and Essential Fish Habitat

3.13.1 Description of the Affected Environment for Finfish and Essential Fish Habitat

3.13.1.1 Finfish

Geographic analysis area: The GAAs used in this EIS define a reasonable boundary for assessing the potential effects, including cumulative effects, resulting from the development of an offshore wind energy industry on the Mid-Atlantic OCS. GAAs for marine biological resources are necessarily large because marine populations range broadly, and cumulative impacts can be expressed over broad areas. GAAs are not used as a basis for analyzing the direct and indirect effects of the Proposed Action, which represent a subset of these broader effects and expressed over a smaller area. These impacts are analyzed specific to each IPF.

The finfish GAA encompasses the Scotian Shelf, Northeast Shelf, and Southeast Shelf Large Marine Ecosystems, which captures most of the movement range within U.S. waters for most species in this group. Because the finfish GAA encompasses the Gulf of Maine down to Cape Hatteras, North Carolina, for the purposes of Project-specific analysis, the focus is on finfish that would be likely to have regular or common occurrences in the RWF and RWEC and could be impacted by Project activities (Figure 3.13-1). The finfish GAA encompasses the extent of potential effects on finfish and their habitats. Thus, while Project-related impacts to finfish habitat are restricted to a relatively small footprint, the GAA for Project-impacts to finfish is necessarily large because marine populations and their dispersal patterns range over broad areas exposed to potential cumulative effects from offshore wind energy development.

Affected environment: Details on baseline conditions of the affected environment for finfish are provided in technical reports developed by Revolution Wind (Inspire Environmental 2021, 2023), which are available on BOEM's public Project website (https://www.boem.gov/renewable-energy/state-activities/revolution-wind-farm-construction-and-operations-plan-april-2021). The information presented here summarizes a refined characterization of benthic habitat conditions developed by BOEM and Revolution Wind working in collaboration with NMFS consistent with updated guidance for mapping benthic habitat (NMFS 2021a). The RWF maximum work area overlaps Cox Ledge, an area of concern for fishery managers because it provides important habitat for several commercially and recreationally important species—notably, spawning habitat for Atlantic cod. A portion of Cox Ledge was designated by the New England Fishery Management Council (NEFMC) as a habitat management area to protect EFH for a number of managed fish species. NOAA acknowledged the importance of Cox Ledge but disapproved the designation because it concluded the proposed gear restrictions approved by the NEFMC would likely be ineffective at minimizing impacts on habitat function (NEFMC 2018; NOAA 2017). On July 30, 2022, the NEFMC approved a new Habitat Area of Particular Concern (HAPC) designation to address concerns over potential adverse impacts from offshore wind development on sensitive hard-bottom habitats and cod spawning activity. The Southern New England HAPC comprises all large-grained complex and complex benthic habitats wherever present within the area bounded by a 10-km (6.2-mile) buffer around the RI/MA and MA WEAs (Plante 2022). The designation is intended to protect high-value complex habitats within this area, emphasizing currently known and potentially suitable areas used by Atlantic cod for spawning (Bachman and Couture 2022; NEFMC 2022). This EFH designation was partially informed by the findings of a 3-year BOEM-funded study investigating the use of Cox Ledge and surroundings by spawning Atlantic cod (#AT-19-08) (Van Hoeck et al. 2023).

The designation will also apply to large-grained complex and complex benthic habitats used by Atlantic herring, Atlantic sea scallop (*Placopecten magellanicus*), little skate (*Leucoraja erinacea*), monkfish, ocean pout (*Zoarces americanus*), red hake, silver hake, windowpane flounder (*Scophthalmus aquosus*), winter flounder (*Pseudopleuronectes americanus*), winter skate (*Leucoraja ocellata*), and yellowtail flounder (*Limanda ferruginea*). This new HAPC designation has not yet been implemented and is pending final approval by NMFS. Given the level of concern raised about potential impacts on Cox Ledge and Atlantic cod, the discussion of potential effects presented in the following sections places emphasis on this and other species of particular concern.

Numerous species of finfish belonging to the demersal, pelagic, and shark assemblages could occur in and near the proposed RWF and RWEC. These include several EFH species (see Section 3.13.1.2) and two ESA-listed species. The finfish resources of the region support diverse and highly valued commercial and recreational fisheries (see Section 3.9). BOEM has funded several surveys of finfish species occurrence in the RI/MA WEA, which are summarized by Guida et al. (2017).

Many of the finfish species found in nearshore marine and estuarine environments were historically used by the region's Native American tribes (Bennet 1955) and are targeted by ongoing tribal subsistence fisheries (BOEM 2020).

Finfish can be divided into two general groupings—demersal and pelagic—based on their primary habitat association. Demersal species spend their adult life stage on or close to the ocean bottom and associate with specific types of benthic habitat. Examples include species like Atlantic cod, red and silver hake, and black sea bass that live on or near the seafloor during one or more life stages and species like skates (Rajidae) and flatfish that spend most of their lives directly on the seafloor. Habitat preferences vary between species. For example, black sea bass, Atlantic cod, and haddock associate primarily with complex, rocky benthic habitats (such as cobbles, boulders, and rocky reefs), while red hake and flounder use biogenic complex habitats (such as mussel or oyster reefs), artificial reefs, and shell habitats as well as hard-bottom reefs in some portions of the region.

Pelagic fishes are generally schooling fish that occupy the middle to upper water column as juveniles and adults. Pelagic species occupy the surface to midwater depths (0 to 3,281 feet [0 to 1,000 m]) from the shoreline to the continental shelf and beyond. Examples include Atlantic herring, bluefish (*Pomatomus saltatrix*), and several shark species. Some demersal species, such as Atlantic cod and black sea bass, have pelagic eggs and larvae. Conversely, some pelagic species, such as Atlantic herring, have benthic eggs. Some purely pelagic species, like tunas (Thunnini), are highly migratory and only occur in the near-coastal and shelf surface waters of the Southern New England-New York Bight in the summer, taking advantage of the abundant prey in warm surface waters. Their eggs and larvae are pelagic and broadly distributed.

These two groups encompass a diversity of species that associate with the full range of environment types that occur in the RWF and RWEC portions of the GAA. Estuarine species, such as summer and winter flounder, are commonly found in nearshore areas, where freshwater inputs from large rivers mix with the ocean. Purely marine species are primarily found in offshore environments and include yellowfin tuna (*Thunnus albacares*), bluefin tuna, bluefish, swordfish, blue shark (*Prionace glauca*), common thresher shark (*Alopias vulpinus*), and shortfin mako shark (*Isurus oxyrinchus*).

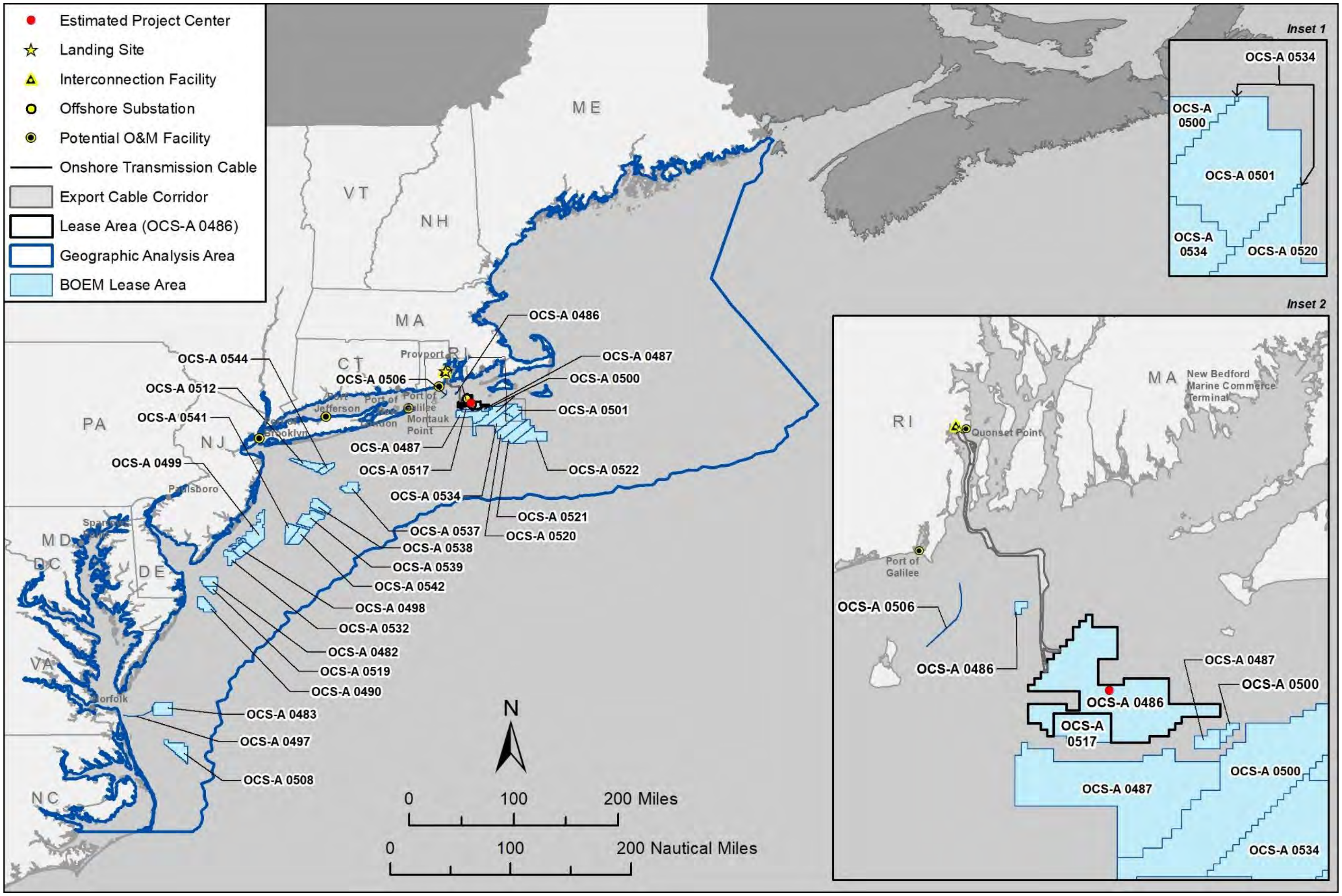

Figure 3.13-1. Geographic analysis area for finfish and essential fish habitat.

Anadromous species spawn in freshwater and migrate to the open ocean to grow to adulthood, using estuarine and nearshore marine habitats for migration and larval and juvenile rearing. Four pelagic species of anadromous fish could be present in the Project vicinity and GAA: American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and Atlantic menhaden (*Brevoortia tyrannus*) (BOEM 2013; Petruny-Parker et al. 2015; Scotti et al. 2010). Additionally, striped bass (*Morone saxatilis*) are likely to use nearshore habitats, and Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*) would use demersal habitats. The catadromous American eel (*Anguilla rostrata*) also occurs as larvae, juvenile glass eels migrating to freshwater, and adults migrating to spawning habitats in the Sargasso Sea. This species uses pelagic habitats on the OCS for larval and juvenile metamorphosis, migration, feeding, and growth (ASMFC 2000).

The demersal and pelagic fish community structure of the Mid-Atlantic and southern New England OCS is shifting due to a combination of factors, including climate change, fishing pressure, and modification of coastal and estuarine habitats (NOAA 2021). For example, the fish community structure in nearby Narraganset Sound has been changing over the past 6 decades, marked by dramatic declines in abundance followed by the slow rebuilding of large predators like sharks (Selachimorpha), the declining abundance of some demersal species (winter flounder, whiting, and red hake), and the increasing abundance for others (Atlantic butterfish, scup [*Stenotomus chrysops*], black sea bass, and squid [Decapodiformes]) (Collie et al. 2008; NOAA 2021). These shifts are mirrored throughout the Mid-Atlantic and southern New England regions (Hare 2016; NOAA 2021).

Five ESA-listed fish species occur in the waters of the Northwest Atlantic OCS: giant manta ray (*Manta birostris*), Atlantic salmon (*Salmo salar*), oceanic whitetip shark (*Carcharhinus longimanus*), Atlantic sturgeon, and shortnose sturgeon (*Acipenser brevirostrum*). Oceanic whitetip sharks are not known to occur in the RWF and RWEC. The oceanic whitetip shark is typically found offshore in the open ocean, on the OCS, or around oceanic islands in water deeper than 604 feet (184 m). The species has a clear preference for open ocean waters between latitudes of 10°N and 10°S but can be found in decreasing numbers out to 30°N and 35°S, with abundance decreasing with greater proximity to continental shelves (Young et al. 2017). This species could conceivably encounter Project vessels in open ocean waters as they travel to the Lease Area from Europe. However, given the low density of oceanic whitetip sharks and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is discountable. Vessel strikes are not identified as a threat in the status review (Young et al. 2017) or the recovery outline (NMFS 2018); therefore, this species is not considered further in this EIS. The giant manta ray and Atlantic sturgeon are expected to occur in the open marine waters of the Mid-Atlantic OCS where they could be exposed to Project-related effects of the RWF and RWEC. Shortnose sturgeon are unlikely to occur in offshore waters but may be present in nearshore coastal waters of Rhode Island. The species has not been reliably documented within Narragansett Bay (Dadswell et al. 1984; NMFS 1998), but individuals from the nearby Connecticut River population could occur there based on observed migratory patterns between other river systems in New England (Dionne et al. 2013; Fernandes et al. 2010). Critical habitat has not been designated for this species.

The giant manta ray is a pelagic relative of the sharks, most commonly found in open ocean waters well to the south of the RWF and RWEC. However, manta rays migrate seasonally over long distances, and the northern extent of their known range extends to upwelling zones along the edge of the continental shelf immediately south of and potentially including the RWF and RWEC. Critical habitat has not been designated for this species (NMFS et al. 2019). The Atlantic sturgeon is a large demersal, estuarine-dependent, anadromous species that historically spawned in medium-sized to large rivers on the U.S. Atlantic Coast from Labrador to Florida (Atlantic Sturgeon Status Review Team 2007). Five separate distinct population segments (DPSs) of Atlantic sturgeon were listed under the ESA in 2012 (NOAA 2012): Chesapeake Bay (endangered), Carolina (endangered), New York Bight (endangered), South Atlantic (endangered), and Gulf of Maine (threatened). Atlantic sturgeon originating from rivers in Canada are currently not listed. The current marine range of Atlantic sturgeon extends from Labrador Inlet, Labrador, Canada, to Cape Canaveral, Florida (NOAA 2012). Designated critical habitat comprises the core riverine and estuarine habitats used by each DPS (NMFS et al. 2017). Features of Atlantic sturgeon critical habitat include temperature, salinity, dissolved oxygen, water depth, and barriers to passage. The only Project activity that may affect Atlantic sturgeon critical habitat are Project vessel transits within the vessel traffic component of the GAA. Vessels from local ports with rivers in the Atlantic sturgeon New York Bight DPS could travel through critical habitat if the ports are located within or at the mouth of river systems designated as critical habitat for Atlantic sturgeon. If vessel transit for the Project includes ports within Atlantic sturgeon critical habitat, vessel travel from existing ports would have no measurable effect on Atlantic sturgeon critical habitat features. Shortnose sturgeon are an amphidromous species, meaning they spawn and live primarily in freshwater but make extensive use of estuarine and nearshore marine habitats in proximity to their natal rivers (Dionne et al. 2013). This species has been listed as endangered under the ESA since its inception. The closest documented population occurs in the lower Connecticut River approximately 50 miles to the west of the mouth of Narragansett Bay, which is within the range of nearshore migration between estuaries observed in other populations (Dionne et al. 2013; Fernandes et al. 2010).

3.13.1.2 Essential Fish Habitat

Geographic analysis area: The GAA for EFH is the same as that described above for finfish (see Figure 3.13-1).

Affected environment: The Magnuson-Stevens Fishery Conservation and Management Act requires federal agencies to consult with NMFS on activities that could adversely affect EFH. NOAA defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NOAA 2004, 2018). The majority of the EFH-listed species occurring in the waters of the Mid-Atlantic and southern New England OCS are managed under federal FMPs developed by the NEFMC and the MAFMC (MAFMC 2019; NEFMC 2018). In addition to these species, several other protected and/or highly migratory species that are managed through FMPs developed by NMFS (2019) are known or likely to occur in the GAA.

EFH-designated species and management groups and a summary of fish stock status that occurs on the southern New England and Mid-Atlantic OCS (MARCO 2019) are presented in Table 3.13-1.

Table 3.13-1. Southern New England and Mid-Atlantic OCS EFH Species, Management Groups, and Fish Stock Summaries

Fishery Management Jurisdiction	Fishery Management Plan	Stock	Is Overfishing Occurring? (harvest exceeds management target)	Is Stock Overfished? (stock abundance is below management target)	Stock Rebuilding Program In Place?
NEFMC	Atlantic Herring	Atlantic herring - Northwestern Atlantic Coast	No	Yes	Year 1 of 5-year plan
	Atlantic Sea Scallop	Sea scallop - Northwestern Atlantic Coast	No	No	No
	Northeast Multispecies	Atlantic cod - Georges Bank	Yes	Yes	Year 19 of 23-year plan
		Haddock - Georges Bank	No	No	No
		Atlantic pollock - Gulf of Maine/Georges Bank	No	No	No
		Red hake - Southern Georges Bank/Mid-Atlantic	Yes	Yes	Year 1 of 10-year plan
		Silver hake - Southern Georges Bank/Mid-Atlantic	No	No	No
		White hake - Gulf of Maine/Georges Bank	No	Yes	Year 2 of 10-year plan
		Winter flounder - Southern New England/Mid-Atlantic	No	No - stock rebuilt	No
		Witch flounder - Northwestern Atlantic Coast	Unknown	Yes	Year 4 of 23-year plan
		Yellowtail flounder - Southern New England/Mid-Atlantic	No	Yes	Year 4 of 10-year plan

Fishery Management Jurisdiction	Fishery Management Plan	Stock	Is Overfishing Occurring? (harvest exceeds management target)	Is Stock Overfished? (stock abundance is below management target)	Stock Rebuilding Program In Place?
NEFMC	Northeast Skate Complex	Little skate - Georges Bank/Southern New England	No	No	No
		Winter skate - Georges Bank/Southern New England	No	No	No
MAFMC	Surfclam/Ocean Quahog	Atlantic surfclam - Mid-Atlantic Coast	No	No	No
		Ocean quahog - Atlantic Coast	No	No	No
	Bluefish	Bluefish - Atlantic Coast	No	Yes	Year 1 of 7-year plan
	Mackerel/Squid/Butterfish	Atlantic mackerel - Gulf of Maine/Cape Hatteras	Yes	Yes	Year 3 of 5-year plan
		Butterfish - Gulf of Maine/Cape Hatteras	No	No	No
		Longfin inshore squid - Georges Bank/Cape Hatteras	Unknown	No	No
		Northern shortfin squid - Northwestern Atlantic Coast	No	Unknown	No
	Summer Flounder/Scup/Black Sea Bass	Black sea bass - Mid-Atlantic Coast	No	No	No
		Scup - Atlantic Coast	No	No	No
		Summer flounder - Mid-Atlantic Coast	No	No	No

Fishery Management Jurisdiction	Fishery Management Plan	Stock	Is Overfishing Occurring? (harvest exceeds management target)	Is Stock Overfished? (stock abundance is below management target)	Stock Rebuilding Program In Place?
NEFMC/ MAFMC	Monkfish	Goosefish - Southern Georges Bank/Mid-Atlantic	No	No	No
	Spiny Dogfish	Spiny dogfish - Atlantic Coast	No	No	No
Atlantic Highly Migratory Species	Consolidated Atlantic Highly Migratory Species	Albacore - North Atlantic	No	No	Not applicable (N/A)
		Blacknose shark - Gulf of Mexico	Unknown	Unknown	N/A
		Bluefin tuna - Western Atlantic	No	Unknown	N/A
		Skipjack tuna - Western Atlantic	No	No	N/A
		Yellowfin tuna - Atlantic	No	No	N/A
		Blue shark - North Atlantic	No	No	N/A
		Dusky shark - Atlantic and Gulf of Mexico	Yes	Yes	Year 15 of 100-year plan
		Sandbar shark - Atlantic and Gulf of Mexico	No	Yes	Year 18 of 66-year plan
		Smooth dogfish - Atlantic	No	No	No
		Shortfin mako - North Atlantic	Yes	Yes	Year 4 of plan
		Tiger shark - Atlantic and Gulf of Mexico	Unknown	Unknown	N/A

Source: NOAA (2022).

Some, but not all, of the EFH species covered by the respective FMPs occur within the RWF and RWEC.

NOAA and fishery management councils also identify HAPCs as a subset of EFH. HAPCs are high-priority areas for conservation, additional management focus, or research because they are rare, sensitive, stressed by development, and/or important to ecosystem function. The only currently designated HAPCs that could be impacted by Project activities are specific habitats for both adult and juvenile summer flounder and juvenile Atlantic cod. However, in July 2022, the NEFMC approved a proposed HAPC designation comprising large-grained complex and complex benthic habitats wherever present within the area bounded by a 6.2-mile buffer around the RI/MA and MA WEAs (Plante 2022). The designation is intended to protect high-value complex habitats within this area, emphasizing currently known and potentially suitable areas used by Atlantic cod for spawning (Bachman and Couture 2022; NEFMC 2022). This designation would also apply to large-grained complex and complex benthic habitats used by Atlantic herring, Atlantic sea scallop, little skate, monkfish, ocean pout, red hake, silver hake, windowpane flounder, winter flounder, winter skate, and yellowtail flounder. This new HAPC designation is currently being finalized and has not yet been implemented.

The summer flounder HAPC includes all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes (i.e., submerged aquatic vegetation [SAV]) in any size bed, as well as loose aggregations found within currently designated adult and juvenile summer flounder EFH. In locations where native SAV species have been eliminated from an area, then exotic species are included (MAFMC et al. 1998). The HAPC for juvenile Atlantic cod is defined as intertidal and benthic structurally complex habitats to a maximum depth of 396 feet (120 m), including eelgrass, mixed sand and gravel, and rocky habitats. The range for juvenile cod in these habitats extends from Maine through, and including portions of Rhode Island. These habitats occur near the RWEC corridor and could be affected by cable emplacement and maintenance and suspended sediment deposition and burial effects.

In the process of developing Project alternatives, BOEM worked collaboratively with NMFS to identify specific areas, or habitat priority zones, within the RWF and RWEC corridor that are of greatest concern for potential adverse impacts to EFH. These habitat priority zones were used to define habitat impact minimization for Alternative C and have been adapted to support the EFH assessment. The zones were modified to provide complete coverage of the maximum work area with contiguous internal boundaries. The modified zones are defined as follows:

- Zone RWF 1: Highest priority area for benthic habitat impact minimization within the Lease Area (boundary modified for EFH assessment)
- Zone RWF 2: Second-highest priority area for benthic habitat impact minimization within the Lease Area (boundary modified for EFH assessment)
- Zones RWF 3a and RWF 3b: Third-highest priority area for benthic habitat impact minimization within the Lease Area (boundary modified for EFH assessment)
- Zone RWF 4: Lowest-priority area for benthic habitat impact minimization within the Lease Area (defined for EFH assessment)
- Zone RWEC-OCS: Portion of RWEC corridor in federal waters (defined for EFH assessment)
- Zone RWEC-RI: Portion of RWEC corridor in Rhode Island waters (defined for EFH assessment)

These habitat priority zones are used to describe existing benthic habitat composition and structure within the maximum work area. This organization supports the characterization of construction and O&M impacts on EFH based on the specific habitat features present within each zone. The habitat priority zones and the distribution of complex, large-grained complex, and soft-bottom benthic habitats within each habitat zone are displayed in Figure 3.13-2 and Figure 3.13-3. Descriptions of each zone, the surveyed area, and proportional distribution of benthic habitat types and features within each zone are presented in the EFH assessment report (BOEM 2023c, 2023d).

BOEM completed an environmental assessment and EFH consultation on the reasonably foreseeable impacts associated with the issuance of leases and subsequent site assessment and site characterization for activities within the RI/MA WEA (BOEM 2013). The assessment included installation and operation of MET towers and buoys and geophysical, geotechnical, archaeological, and biological surveys. BOEM determined that the Project would not significantly affect the quality and quantity of EFH in the environmental assessment's action area. In a letter dated July 30, 2012, the NMFS (2012) concurred with several of BOEM’s standard operating conditions regarding protections they would confer to marine fish and did not raise any objections to lease issuance. However, because the exact placement of MET towers and buoys within the WEA were unknown at the time, the NMFS requested to participate in the review of individual site assessment plans in order to make final conclusions regarding impacts to EFH from site assessment activities. The Project EFH assessment report was submitted to NMFS on February 6, 2023 (BOEM 2023c, 2023d).

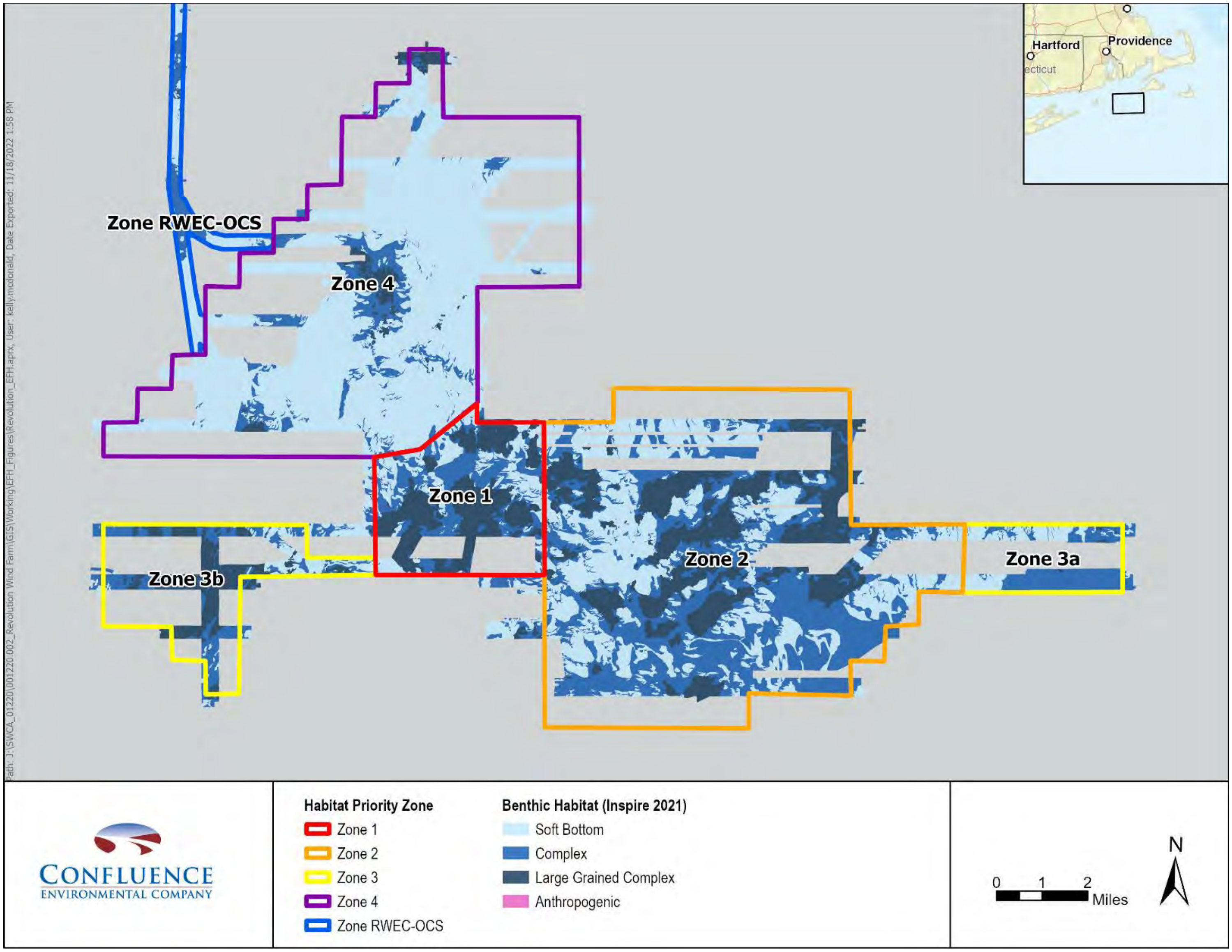

Figure 3.13-2. Habitat zone boundaries and distribution of large-grained complex, complex, and soft-bottom benthic habitats within the Lease Area (Inspire Environmental 2023).

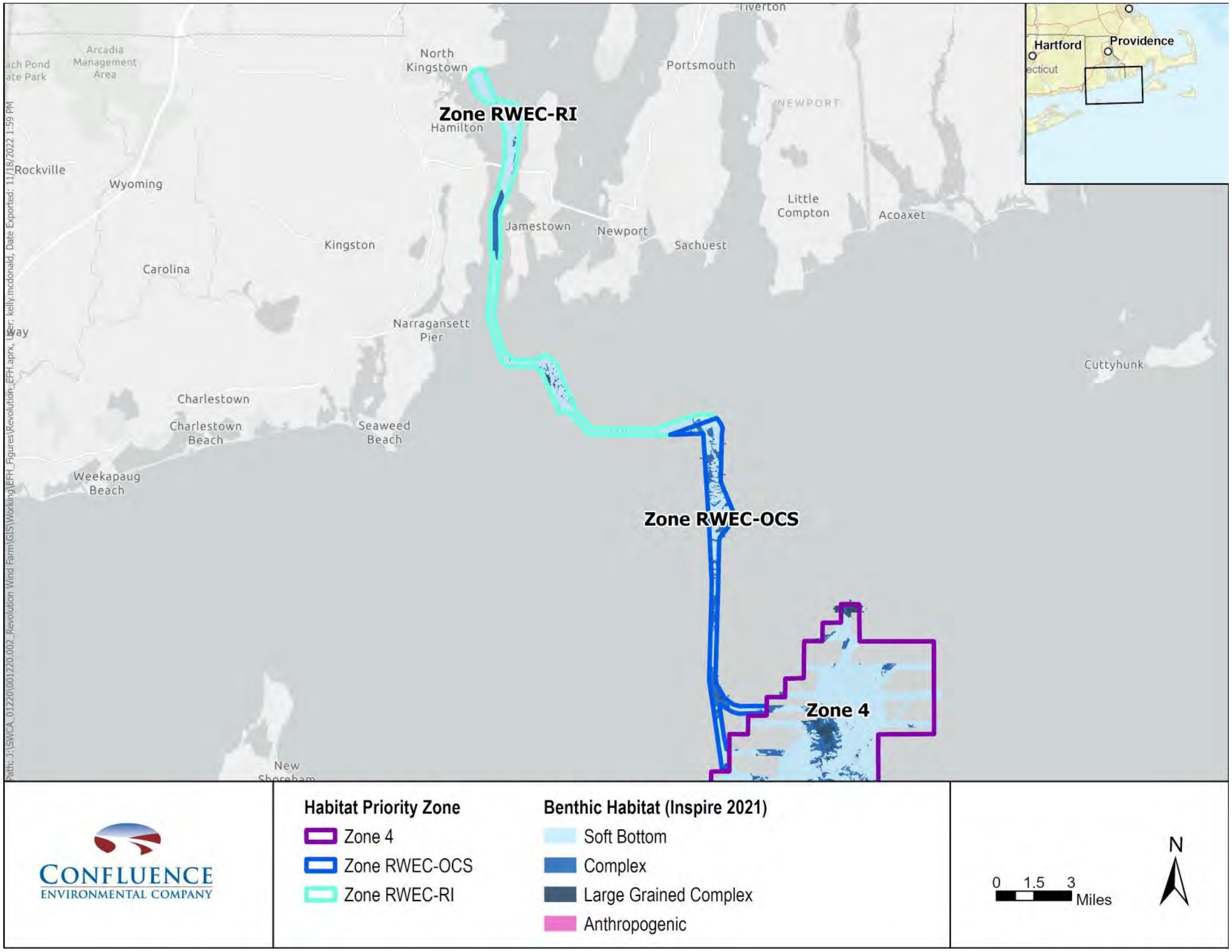

Figure 3.13-3. Habitat zone boundaries and distribution of large-grained complex, complex, and soft-bottom benthic habitats within the RWEC corridor (Inspire Environmental 2023).

3.13.2 Environmental Consequences

3.13.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

The analysis presented in this section considers the impacts resulting from the maximum-case scenario under the PDE approach developed by BOEM to support offshore wind project development (Rowe et al. 2017). The maximum-case scenario specifications defined in Appendix D, Table D-1 are PDE parameters used to conduct this analysis. Several Project parameters could change during the development of the final Project configuration, potentially reducing the extent and/or intensity of impacts resulting from the associated IPFs. The design parameters in Table 3.13-2 would result in reduced impacts relative to those generated by the design elements considered under the PDE.

Table 3.13-2. Project Design Parameters That Could Reduce Impacts

Design Parameter	Description
Fewer WTGs could be permitted	Resulting in fewer offshore structures and reduced IAC length. This would reduce the extent of short-term to permanent impacts on EFH and finfish by reducing the extent of habitat disturbance and suspended sediment deposition impacts from installation of foundations, cables, and scour and cable protection, and associated vessel anchoring activities; reducing the extent and duration of underwater noise impacts from WTG foundation installation; and reducing the extent of reef and hydrodynamic effects resulting from structure presence.
Foundation and cable micrositing	Foundation locations and cable routing could be modified to avoid and minimize certain habitat impacts to the greatest extent practicable within design limits. This would reduce long-term to permanent impacts to EFH habitat by reducing the extent of disturbance in large-grained complex and complex habitats.
The use of a casing pipe method to construct the RWEC sea-to-shore transition	Would eliminate the need for a temporary cofferdam, resulting in less extensive acoustic and vibration impacts than vibratory pile driving to construct a cofferdam (Zeddies 2021).
The use of a temporary cofferdam for RWEC sea-to-shore transition construction	Would reduce turbidity, sediment deposition, and burial effects on finfish and EFH.

See Appendix E1 for a summary of IPFs analyzed for finfish and EFH across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have a negligible adverse effect are excluded from Chapter 3 and provided in Appendix E, Table E2-4. Where feasible, calculations for specific alternative impacts are provided in Appendix E4, to facilitate reader comparison across alternatives. The duration of impacts (temporal scale) disclosed for this resource deviate slightly from general guidelines provided in Section 3.3.

Table 3.13-3 provides a comparison of all evaluated IPFs for finfish and EFH across alternatives. Each alternative analysis discussion consists of the construction and installation phase, the O&M phase, the decommissioning phase, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion. This comparison considers the implementation of all EPMs proposed by Revolution Wind to avoid and minimize adverse impacts on finfish and EFH. These EPMs are summarized in Appendix F, Table F-1. Additional EMPs that BOEM could propose, as well as EPMs agreed upon through consultations and agency-to-agency negotiations, are summarized in Appendix F, Tables F-2 and F-3.

A detailed analysis of the Proposed Action is provided following the table. Detailed analysis of other considered action alternatives is also provided below the table if analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component. For finfish and EFH, onshore Project activities would not result in impacts to marine resources. Therefore, onshore impacts would have no measurable effects on habitats used by any finfish species and are not evaluated below.

The conclusion section within each alternative analysis discussion includes rationale for the overall effect call determination. Overall, each alternative would result in **moderate** adverse to **moderate** beneficial impacts on finfish and EFH in the GAA, varying by species. Moderate adverse effects could occur 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. Some finfish species could realize moderate beneficial effects from reef effects, which would increase the extent and quality of local habitat for and the abundance of species common to the Lease Area and RWEC corridor over the life of the Project.

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Table 3.13-3. Alternative Comparison Summary for Finfish and Essential Fish Habitat

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
Finfish							
Accidental releases and discharges	**Offshore:** Offshore wind energy development could result in the accidental release of water quality contaminants or trash/debris, which could lead to an increase in debris and pollution in the GAA. BOEM prohibits the discharge or disposal of solid debris into offshore waters during any activity associated with the construction and operations of offshore wind energy facilities (30 CFR 250.300). BOEM would require all project construction vessels to adhere to existing state and federal regulations related to ballast and bilge water discharge. Compliance with these and other requirements would effectively minimize releases of trash and debris or nonnative species invasions through ballast water discharge, resulting in ecologically **negligible** adverse impacts.	**Offshore:** BOEM prohibits the discharge or disposal of solid debris into offshore waters during any activity associated with the construction and operations of offshore wind energy facilities (30 CFR 250.300). The USCG similarly prohibits the dumping of trash or debris capable of posing entanglement or ingestion risk (MARPOL, Annex V, Public Law 100−220 (101 Stat. 1458)). The Project would comply with these requirements (VHB 2023). The Project proponent would also be required to comply with other state and federal regulations to avoid the introduction of nonnative species. Given these restrictions, the impact to finfish from trash and debris from the Project is **negligible** adverse. Given the low potential for spills and the minimal risk of exposure to small short-term spills, the impact from Project-related petroleum spills under reasonably foreseeable circumstances is **negligible** adverse. In the unlikely event of a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, **minor** to **moderate** adverse effects on finfish could result. BOEM estimates that the Project when combined with other offshore wind projects would result in approximately 34 million gallons of coolants, fuel, oils, and lubricants cumulatively stored within WTGs and OSSs within the finfish GAA. All vessels associated with the Proposed Action and other offshore wind projects would comply with USCG requirements for the prevention and control of oil and fuel spills. For this reason, the Proposed Action when combined with other past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts on finfish ranging from short term to long term in duration.	**Offshore:** See Section 3.13.2.6.1 for construction impact analysis. The risk of accidental releases and discharges under Alternatives C through F would be similar as the Proposed Action and would have a **negligible** adverse impact on finfish because of the low probability of the risk and EPM implementation. The Project would comply with all requirements that disallow the discharge or disposal of solid trash or debris (VHB 2023). Moreover, Alternatives C through F would similarly include inspection of offshore structures and removal of derelict fishing gear and other accumulated debris. This would provide a mechanism for removing potentially harmful marine debris from the environment. This would constitute a **minor** beneficial effect on finfish. BOEM anticipates that all projects would follow strict oil spill prevention and response procedures, effectively avoiding the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. For this reason, Alternatives C through F when combined with other past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts on finfish ranging from short term to long term in duration.				**Offshore:** See Section 3.13.2.8.1 for construction impact analysis. The risk of accidental releases and discharges under Alternative G would be similar to the Proposed Action and would have a **negligible** adverse impact on finfish because of the low probability of the risk and EPM implementation. The Project would comply with all requirements that disallow the discharge or disposal of solid trash or debris (VHB 2023). Moreover, Alternative G would similarly include inspection of offshore structures and removal of derelict fishing gear and other accumulated debris. This would provide a mechanism for removing potentially harmful marine debris from the environment. This would constitute a **minor** beneficial effect on finfish. BOEM anticipates that all projects would follow strict oil spill prevention and response procedures, effectively avoiding the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. For this reason, Alternative G when combined with other past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts on finfish ranging from short term to long term in duration.
Anchoring and new cable emplacement/ maintenance	**Offshore:** Anchoring and cable installation activities would involve direct disturbance of the seafloor, leading to direct impacts on benthic habitats used by demersal finfish. However, these	Offshore: Finfish within the construction footprint would be exposed to risk of displacement, crushing, and burial during seafloor preparation of cable corridors, cable installation, placement of cable protection, and vessel anchoring. These	Offshore: See Section 3.13.2.6.1 for construction impact analysis. Similar to the Proposed Action, finfish within the construction footprint would be exposed to risk of displacement, crushing, and burial during seafloor preparation of cable corridors, cable installation, placement of cable protection, and vessel anchoring. These activities would also impact benthic habitats used by managed finfish, including complex and large-grained complex				**Offshore:** See Section 3.13.2.8.1 for construction impact analysis. Alternative G would reduce the total length of IAC relative to the Proposed Action, meaning that the total amount of cable

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	impacts would be limited in extent relative to the total amount of habitat available in the finfish GAA. The affected habitats would recover to fully functional condition for finfish without mitigation. Therefore, impacts to finfish from vessel anchoring and cable installation would be **minor** adverse.	activities would also impact benthic habitats used by managed finfish, including complex and large-grained complex habitats that support Atlantic cod spawning. Cod spawning activity within the Lease Area could be disturbed if anchoring and cable emplacement activities (e.g., grapnel runs and jet plowing) occur in proximity. EPMs committed to by Revolution Wind (see Table F-1, Appendix F)—such as using a boulder grab and a work-class remotely operated vehicle boulder skid for most boulder relocations, siting the RWF and RWEC to avoid hard-bottom habitats, and developing a construction anchoring plan—would minimize impacts and modifications to large-grained complex and complex habitats that support spawning cod and other managed finfish (see Section 3.13.2.10 and Table 3.13-13). Disturbance impacts to soft-bottom benthic habitats and associated fish species would be short term, and these habitats and species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could be long term to permanent. Long-term impacts to habitat-forming organisms in complex habitats would require several years to recover full habitat function. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat type. Although habitat structure may be altered, habitat composition in the affected areas would recover to functional condition over the life of the Project. Activities resulting in the entrainment of eggs and larvae would constitute a short-term adverse impact on finfish that would not result in measurable population-level impacts. On balance, these impacts would be minor to moderate adverse. Anchoring, cable protection maintenance, and the eventual decommissioning and removal of buried cables would produce similar effects on finfish as those described for Project construction. These would include direct disturbance of the seafloor, suspended sediment deposition in the	habitats that support Atlantic cod spawning. Cod spawning activity could be disturbed if anchoring and cable emplacement activities (e.g., grapnel runs and jet plowing) occur in proximity. EPMs committed to by Revolution Wind (see Table F-1, Appendix F)— such as using a boulder grab and a work-class remotely operated vehicle boulder skid for most boulder relocations, siting the RWF and RWEC to avoid hard-bottom habitats, and developing a construction anchoring plan—would minimize impacts and modifications to large-grained complex and complex habitats that support spawning cod and other managed finfish (see Section 3.13.2.10 and Table 3.13-13). Disturbance impacts to soft-bottom benthic habitats and associated fish species would be short term, and these habitats and species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take several years to recover to full habitat function. Configurations of Alternative C would reduce the total number of turbines and acres of impacts to complex and large-grained complex habitats within Zones RWF 1 and 2 that support managed finfish and would reduce the likelihood of disturbances to Atlantic cod spawning activity relative to the Proposed Action and Alternatives D, E, F, and G. Combining Alternatives C and F would result in further reductions of impacts due to the reduction in turbines and associated reductions in activities that could impact Atlantic cod (i.e., pile driving, anchoring, cable emplacement, and seafloor preparation). Alternatives C through F would reduce the total length of IAC relative to the Proposed Action, meaning that the total amount of cable construction and maintenance-related impacts on benthic habitat and finfish would decrease commensurately. However, the effects would still be minor to moderate adverse because each alternative may result in either notable and measurable adverse impacts to the richness or abundance of local finfish species common to the Lease Area or to the extent and quality of local habitat relied upon by finfish common to the Lease Area. Although, finfish and the habitats they rely upon would be expected to recover completely either without remedial or mitigating action or when remedial or mitigating action is taken. Alternatives C through F surface occupancy would noticeably reduce the cumulative impact acreage across projects relative to the Proposed Action, but the nature, duration, and general scope of effects would otherwise be similar. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Disturbance impacts to soft-bottom benthic habitats and associated fish species would be short term, and these habitats and species would be expected to fully recover within 18 to 36 months, whereas impacts on complex benthic habitats could take several years to decades to fully recover. Therefore, Alternative C when combined with past, present, and reasonably foreseeable projects would result in minor to moderate adverse cumulative impacts to fish habitat and finfish.				construction and maintenance-related impacts on benthic EFH and finfish would decrease and the proportional distribution of impacts in soft-bottomed habitat would increase. However, the nature and magnitude of those impacts would be broadly similar to the Proposed Action; therefore, the resulting effects would still be **minor to moderate** adverse. Alternative G surface occupancy would noticeably reduce the cumulative impact acreage across projects relative to the Proposed Action, but the nature, duration, and general scope of effects would otherwise be similar. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Atlantic cod spawning could be disturbed if anchoring and cable emplacement activities (e.g., grapnel runs and jet plowing) are occurring in proximity. The base configuration of Alternative G would reduce the total acres of benthic EFH impacts relative to the Proposed Action, and specifically avoid areas leading to less extensive impacts to large-grained complex and complex benthic habitats that support managed finfish, including spawning cod. Alternatives G1 through G3 would further decrease impacts to large-grained complex and complex benthic habitats from vessel anchoring, cable installation and cable protection, and seafloor preparation for foundation installation. Alternative G1 would result in less anchoring and cable emplacement/maintenance activity in the central portion of Zone RWF 1 compared to Alternatives G2 and G3. Most of the recent cod spawning activity within the Lease Area has been observed in the Alternative G2 and G3 areas (Van Hoeck et al. 2023). However, Alternative G1 would still result in anchoring and cable emplacement/maintenance activities that overlap areas observed to support cod spawning relative to Alternative C, which avoids the placement of WTGs

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		surrounding area, and injury and displacement of finfish using these habitats. The IAC, OSS-link cable, and RWEC would be removed from the seafloor during Project decommissioning. Removal of cable protection and extraction of the cable from the seafloor would disturb sediments, releasing TSSs into the water column. These activities would result in short-term minor adverse impacts to finfish. BOEM estimates a cumulative total of 11,631 acres of anchoring and mooring-related disturbance and 105,390 acres of cabling-related disturbance for the Proposed Action plus all other future offshore wind projects within the finfish GAA. Therefore, the Proposed Action when combined with past, present, and reasonably foreseeable projects and other stressors would result in minor to moderate adverse cumulative impacts to finfish.					within Zone RWF 1 and most of Zone RWF 2. EPMs committed to by Revolution Wind (see Table F-1, Appendix F)— such as using a boulder grab and a work-class remotely operated vehicle boulder skid for most boulder relocations, siting the RWF and RWEC to avoid hard-bottom habitats, and developing a construction anchoring plan—would minimize impacts and modifications to large-grained complex and complex habitats that support spawning cod and other managed finfish (see Section 3.13.2.10 and Table 3.13-13). In addition, BOEM-proposed mitigation and monitoring methods in the EFH assessment (see Table 3.13-13, Section 3.13.2.10) and incorporated into Alternative G—such as micrositing, developing an anchoring plan for both construction and O&M, and the live and hard bottom habitat mapping and avoidance mitigation—would further reduce impacts to benthic EFH that support managed finfish and cod spawning. Disturbance impacts to soft-bottom benthic habitats and associated fish species would be short term, and these habitats and fish species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could be long term to permanent. Long-term impacts to habitat-forming organisms in complex habitats would require several years to recover full habitat function. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat type. Although habitat structure may be altered, habitat composition in the affected areas would recover to functional condition over the life of the Project. Therefore, Alternative G when combined with past, present, and reasonably foreseeable projects would result in **minor** to

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							moderate adverse cumulative impacts to fish habitat and finfish.
Bycatch	**Offshore:** A range of monitoring activities has been proposed to evaluate the short-term and long-term effects of existing and planned offshore wind development on biological resources and is also likely for future wind energy projects on the OCS. Some of these monitoring activities are likely to affect finfish through direct sampling and the potential for bycatch and/or damage by sample collection gear. Research and monitoring activities related to offshore wind would not necessarily result in an increase in bycatch-related impacts, although the distribution of those impacts could change. Given this, any bycatch-related impacts on finfish would be **negligible** to **minor** adverse and short term in duration.	**Offshore:** Revolution Wind is proposing to implement the fisheries and benthic monitoring plan (FRMP) as part of the Proposed Action (Revolution Wind and Inspire Environmental 2023). The FRMP employs a variety of survey methods to evaluate the effect of Project construction and operations on benthic habitat structure and composition and economically valuable finfish species. Although the FRMP would result in unavoidable impacts to individual finfish, the extent of habitat disturbance and the number of organisms affected would be small in comparison to the baseline level of impacts from commercial fisheries and would not measurably impact the viability of any species at the population level. Given this, all habitat impacts from FRMP implementation would be short term in duration. The intensity and duration of impacts anticipated from FRMP implementation would constitute a **minor** adverse cumulative effect on finfish.	**Offshore:** The Project would implement the FRMP regardless of the alternative or alternative configuration selected. The impacts of the FRMP on finfish would therefore be the same under Alternatives C through F as the Proposed Action. Therefore, implementation of the FRMP in combination with the anticipated impacts of other planned and likely future monitoring activities would result in **minor** adverse cumulative effects to finfish in the GAA. Alternatives C through F and other planned and future offshore wind energy projects would include fisheries and benthic habitat monitoring plans to gather information about the effects of wind energy development on finfish and other marine resources. These activities would increase knowledge about finfish use of the Mid-Atlantic OCS and the structure and composition of their habitats. This information could lead to improved management of finfish species and key habitats. This would constitute a **minor** beneficial cumulative effect for finfish resources.				**Offshore:** The Project would implement the FRMP regardless of the alternative selected. The impacts of the FRMP on finfish would therefore be the same under Alternative G as the Proposed Action. Therefore, implementation of the FRMP in combination with the anticipated impacts of other planned and likely future monitoring activities would result in **minor** adverse cumulative effects to finfish in the GAA. Alternative G and other planned and future offshore wind energy projects would include fisheries and benthic habitat monitoring plans to gather information about the effects of wind energy development on finfish and other marine resources. These activities would increase knowledge about finfish use of the Mid-Atlantic OCS and the structure and composition of their habitats. This information could lead to improved management of finfish species and key habitats. This would constitute a **minor** beneficial cumulative effect for finfish resources.
Climate change	**Offshore:** Global climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These trends are expected to continue under the No Action Alternative. The intensity of impacts to finfish from climate change are uncertain but are anticipated to range from minor beneficial to **moderate** adverse overall, varying in significance by species.	**Offshore:** The types of impacts from global climate change described for the No Action Alternative would occur under the Proposed Action, but the Proposed Action could also contribute to a long-term net decrease in GHG emissions. This difference may not be measurable but would be expected to help reduce climate change impacts, resulting in **moderate** adverse cumulative impacts.	**Offshore:** Climate change–related impacts to finfish under Alternative C would be the same as the Proposed Action. Ongoing trends associated with climate change, including increases in water temperature, ocean acidification, changes in runoff and circulation patterns, and species range shifts, are expected to continue under Alternatives C through F. The intensity of climate change cumulative impacts on finfish is uncertain and is likely to vary considerably between species, resulting in **moderate** adverse cumulative impacts.				**Offshore:** Climate change–related impacts to finfish under Alternative G would be the same as the Proposed Action. Ongoing trends associated with climate change, including increases in water temperature, ocean acidification, changes in runoff and circulation patterns, and species range shifts, are expected to continue under Alternative G. The intensity of climate change cumulative impacts on finfish is uncertain and is likely to vary considerably between species, resulting in **moderate** adverse cumulative impacts.
EMF	**Offshore:** Under the No Action Alternative, up to 13,469 miles of cable installation would be added in the finfish GAA, producing EMF in the immediate vicinity of each cable during operations. Localized and short-term EMF effects on individual finfish would occur throughout	**Offshore:** Behavioral responses have been observed in some fish species exposed to EMFs, but clear relationships have yet to be established. The Project includes design measures to minimize EMF impacts. Rapid dissipation of EMF over distance therefore means that the effects are	**Offshore:** Cable installation would not result in EMF impacts. Alternatives C through F would result in similar EMF impacts on finfish to the Proposed Action, but those impacts would be reduced in extent due to reductions in the overall length of IAC cable, and the total area exposed would vary depending on the configuration selected (see Table 3.6-10, Table 3.6-26, Table 3.6-27, and Table 3.6-28). The highest EMF levels would occur immediately above exposed cable segments and are the most likely to be detectable by finfish. Any measurable EMF effects, should they occur, would likely be limited to temporary biologically insignificant				**Offshore:** Cable installation would not result in EMF impacts. Project O&M under Alternative G would result in similar EMF impacts on finfish to the Proposed Action, but those impacts would be reduced in extent due to reductions in the overall length of IAC cable and the total area

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	the life of each wind energy project but are unlikely to have measurable population-level effects on any species at the scale of the GAA. Therefore, EMF from planned and potential future activities would have a **negligible to minor** adverse effect if HVAC is used, or **moderate** adverse if HVDC is used.	highly localized and are expected to be **minor** adverse. Although uncertainties remain, future actions that produce EMF effects on the order of those generated by the Proposed Action are unlikely to have significant cumulative effects on finfish. BOEM anticipates that future offshore wind energy projects in the GAA would use HVAC transmission and apply similar design measures to avoid and minimize EMF effects on the environment. Cumulative EMF impacts resulting from the Proposed Action in combination with past, present, and reasonably foreseeable activities would therefore result in **minor** adverse effects on finfish from exposure to detectable levels of EMF in limited areas if HVAC is used, or **moderate** adverse if HVDC is used.	behavioral effects. EMF strength would diminish rapidly with distance, becoming undetectable within approximately 30 feet of the cable path (Exponent 2023), resulting in **minor** adverse effects. EMF effects under Alternatives C through F would combine with those generated by the 13,717 miles of new and existing transmission cables from the other new offshore wind facilities planned on the Mid-Atlantic OCS as well as other existing transmission cables. These cumulative effects would be similar to the No Action Alternative but would occur over a larger area, as determined by the broader Project footprint. Cumulative impacts to finfish would therefore be **minor** adverse if HVAC is used, or **moderate** adverse if HVDC is used.				exposed. IAC length under Alternative G would decrease by 39.2 miles relative to the Proposed Action. Alternatives G1, G2, and G3 would decrease IAC length by an additional 9.9, 11.5, and 11.5 miles, respectively (see Table 3.6-10, Table 3.6-26, Table 3.6-27, and Table 3.6-28). The highest EMF levels would occur immediately above exposed cable segments and are the most likely to be detectable by finfish. Any measurable EMF effects, should they occur, would likely be limited to temporary biologically insignificant behavioral effects. EMF strength would diminish rapidly with distance, becoming undetectable within approximately 30 feet of the cable path (Exponent 2023), resulting in **minor** adverse effects. EMF effects under Alternative G would combine with those generated by the 13,717 miles of new and existing transmission cables from the other new offshore wind facilities planned on the Mid-Atlantic OCS as well as other existing transmission cables. These cumulative effects would be similar in nature to the No Action Alternative but would occur over a larger area, as determined by the broader Project footprint. Cumulative impacts to finfish would therefore be **minor** adverse if HVAC is used, or **moderate** adverse if HVDC is used.
Noise	**Offshore:** Future offshore wind projects would result in noise-generating activities, specifically impact pile driving, HRG surveys, construction and O&M vessel use, and WTG operations. Available information suggests the effects of operational underwater noise from future activities would occur for the life of the projects, would not have population-level effects, and would therefore be **minor** adverse for some species and **negligible** to **minor** adverse for others. On balance, construction noise impacts from future activities that would occur for the life of the projects	**Offshore:** Project construction is likely to result in a short-term to long-term noise impacts sufficient to cause a range of effects on finfish. These effects range from behavioral responses, to masking of biologically important sounds and temporary hearing threshold shifts, to direct injury and mortality. The significance of these effects is likely to vary by species, depending on the number of individuals exposed and the degree to which noise impacts might interfere with important biological functions like spawning. The Proposed Action would include the full build-out of the RWF, which has the potential to disturb spawning Atlantic cod. Time-of-year (TOY) restrictions for pile-driving activity (January through April and December with contingencies)	**Offshore**: See Section 3.13.2.4.1 for construction impacts. Project construction and operational noise effects on finfish under Alternatives C through F would be similar in magnitude but reduced in extent relative to the Proposed Action. The same O&M vessels would be used, but fewer vessel trips would be required overall, so the extent and duration of vessel-related noise exposure would also decrease. Configurations of Alternative C would reduce the level of activity and associated noise (e.g., pile driving) relative to the Proposed Action and to Alternative D, E, and F, thereby reducing the geographic extent and duration of noise impacts where Atlantic cod spawning activity in the Lease Area has primarily been observed (i.e., Zone RWF 1) (Van Hoeck et al. 2023). Configurations of Alternatives C and F would result in further reductions of noise impacts due to the reduction in turbines and associated reductions in activities (construction and O&M-related noise, seafloor preparation, etc.) in areas that support spawning cod and other managed finfish that use complex habitats. TOY restrictions for pile-driving activity (January through April and December with contingencies) would reduce the temporal extent of impacts to Atlantic cod spawning, which existing data indicate is occurring both within (primarily in Zone RWF 1) and outside the Lease				**Offshore:** See Section 3.13.2.4.1 for construction impacts. Project construction and operational noise effects on finfish under Alternative G would be similar in magnitude but reduced in extent relative to the Proposed Action. Relative to the Proposed Action, the proposed configurations of Alternative G would construct and operate fewer WTGs and limit the number of WTGs installed in complex and large-grained complex habitats. This would reduce the extent and duration of impacts in these habitat types, which are known to support Atlantic cod spawning and provide habitat functions for

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	would likely range from **minor** to **moderate** adverse.	would reduce the temporal extent of adverse impacts to cod spawning, which data indicate is occurring both within (primarily in Zone RWF 1) and outside the Lease Area from October through March (DeCelles et al. 2017; Inspire Environmental 2018, 2019; Van Hoeck et al. 2023). In addition, ramp-up or soft starts would be used at the beginning of each pile segment during pile driving and/or vibratory pile driving to provide additional protection to mobile species in the vicinity by allowing them to vacate the area prior to the commencement of pile-diving activities, and Revolution Wind would coordinate with Rhode Island Department of Environmental Management (RIDEM) and NOAA NMFS regarding TOY restrictions through the permitting process and would adhere to requirements imposed by these agencies (e.g., TOY restrictions to avoid and/or minimize impacts to winter flounder). On balance, construction noise impacts on finfish would likely range from **minor** to **moderate** adverse. Measurable operational noise would result from the Proposed Action, producing effects detectable by finfish. Those effects are likely to vary in significance by species depending on hearing sensitivity. Effects on species that lack a swim bladder (like sharks, rays, and flatfish) and hearing generalist species (like ocean pout, butterfish, scup, and tunas) are likely to be biologically insignificant. Operational noise could reduce the ability of hearing specialist species (like Atlantic cod, haddock, Atlantic pollock, and hake) to communicate effectively. However, this impact would only be expected to occur within a few hundred feet of each turbine (HDR 2019), and the likelihood of effects (e.g., negative effects on reproduction and survival) in the wild around operational offshore wind farms is unknown (Mooney et al. 2020). Therefore, the effects could range from **negligible** to **minor** adverse based on currently available information. Decommissioning of the RWF and RWEC would lead to impacts similar to those generated during construction, with the exception that there would be no pile-driving impacts. The impacts of short-term seafloor disturbance and water quality	Area between October and March (DeCelles et al. 2017; Inspire Environmental 2019a, 2020; Van Hoeck et al. 2023). In addition, ramp-up or soft starts would be used at the beginning of each pile segment during pile driving and/or vibratory pile driving to provide additional protection to mobile species in the vicinity by allowing them to vacate the area prior to the commencement of pile-diving activities, and Revolution Wind would coordinate with RIDEM and NOAA NMFS regarding TOY restrictions through the permitting process and would adhere to requirements imposed by these agencies (e.g., TOY restrictions to avoid and/or minimize impacts to winter flounder). Proposed mitigations, such as implementation of the passive acoustic monitoring [PAM] plan, would improve understanding of these potential impacts and inform future management and mitigation measures. On balance, construction noise impacts on finfish would likely range from minor to moderate adverse because each alternative may result in either notable and measurable adverse impacts to the richness or abundance of local finfish species common to the Lease Area and RWEC corridor or to the extent and quality of local habitat relied upon by finfish common to these areas. Although, finfish and the habitats they rely on would be expected to recover completely either without remedial or mitigating action or when remedial or mitigating action is taken. Noise effects on finfish from WTG operations could range from negligible to minor adverse depending on how each species uses the affected area during periods when communication is important. For example, operational noise exceeding ambient levels could cause masking effects that reduce the effective communication range for species like cod and haddock. However, this impact would only be expected to occur within a limited area (i.e., within a few hundred feet of a turbine) (HDR 2019), and the likelihood of effects (e.g., negative effects on survival and reproduction) in the wild around operational offshore wind farms is unknown (Van Hoeck et al. 2023; Mooney et al. 2020). Alternatives C through F effects could be additive to areas ensonified by other temporally or spatially overlapping future activities. This could include cumulative impacts to ESA-listed Atlantic sturgeon and manta ray. Shortnose sturgeon are unlikely to be exposed to impact pile-driving noise but could be exposed to underwater noise from UXO detonation and RWEC construction activities in or near Narragansett Bay. Cumulative impacts to shortnose sturgeon are unlikely to occur because their distribution is limited to habitats that are unlikely to be affected by other planned and potential future projects. Fish near impact and vibratory pile-driving activities and UXO detonation could be injured or killed, whereas behavioral effects on fish would extend over greater distances due to vessel activity and O&M-related noise. Such effects, particularly O&M-related noise, would be long term in duration but are unlikely to have a measurable effect on any finfish population at the scale of the GAA. On this basis, cumulative effects on finfish are likely to be negligible to moderate adverse.				other managed fish species. Of the four proposed configurations of Alternative G, Alternative G1 would result in the smallest number of WTGs in the area where the majority of recent cod spawning activity in the Lease Area has been observed (Van Hoeck et al. 2023). Alternative G, particularly Alternative G1, would result in less WTG foundation overlap with cod spawning habitat than any configuration of Alternatives D through F, but more than the two proposed configurations of Alternative C. TOY restrictions for pile-driving activity (January through April) would reduce the temporal extent of impacts to Atlantic cod spawning, which existing data indicate is occurring both within (primarily in Zone RWF 1) and outside the Lease Area between October and March (DeCelles et al. 2017; Inspire Environmental 2019a, 2020; Van Hoeck et al. 2023). In addition, BOEM-proposed mitigation and monitoring methods in the EFH Assessment (see Table 3.13-13, Section 3.13.2.10) and incorporated into Alternative G—such as a TOY restrictions for pile driving from January through April with the addition of December with contingencies and potential IAC installation restrictions pending data collected as part of an Atlantic cod spawning monitoring plan—would help avoid and/or minimize impacts to spawning Atlantic cod and inform future mitigations and monitoring methods. On balance, construction noise impacts on finfish would likely range from **minor** to **moderate** adverse. Alternative G would employ the same types of O&M vessels on a similar schedule to the Proposed Action, but fewer vessel trips would be required overall, so the extent and duration of vessel-related noise exposure would also decrease. Noise effects on finfish from WTG operations could range from **negligible** to **minor** adverse depending on how each species uses the affected area during periods when communication is

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		effects on fish would be **negligible** to **minor** adverse. The construction of up to 16 other offshore wind facilities within the GAA for finfish and EFH would result in underwater noise impacts capable of causing short-term injury or behavioral effects on finfish. Three projects within the RI/MA WEA, Sunrise Wind, New England Wind Phase 1, and South Coast Wind, would be constructed during the same period as Revolution Wind (see Table E3-1, Appendix E-3) and could conceivably result in cumulative behavioral-level noise effects on finfish. Vessel noise from the construction and installation as well as O&M activities could cause startle and avoidance responses in fish but would not cause injury. Impacts from O&M vessels and from operations of the WTGs would be permanent across the life of the Project and could result in behavioral responses. Therefore, the cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would be **negligible** to **moderate** adverse. The Proposed Action and other planned and future offshore wind energy projects would include fisheries and benthic habitat monitoring plans to gather information about the effects of wind energy development on finfish and other marine resources. These activities would increase knowledge about finfish use of the Mid-Atlantic OCS and the structure and composition of their habitats. This information could lead to improved management of finfish species and key habitats. This would constitute a **minor** beneficial cumulative effect on finfish resources.					important. For example, operational noise exceeding ambient levels could cause masking effects that reduce the effective communication range for species like cod and haddock. Alternative G effects could be additive to areas ensonified by other temporally or spatially overlapping future activities. This could include cumulative impacts to ESA-listed Atlantic sturgeon and manta ray. Shortnose sturgeon are unlikely to be exposed to impact pile-driving noise but could be exposed to underwater noise from UXO detonation and RWEC construction activities in or near Narragansett Bay. Cumulative impacts to shortnose sturgeon are unlikely to occur because their distribution is limited to habitats that are unlikely to be affected by other planned and potential future projects. Fish near impact and vibratory pile-driving activities and UXO detonation could be injured or killed, whereas behavioral effects on fish would extend over greater distances due to vessel activity and O&M-related noise. Such effects, particularly O&M-related noise, would be long term but are unlikely to have a measurable effect on any finfish population at the scale of the GAA. On this basis, cumulative effects on finfish are likely to be **minor to moderate** adverse.

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Presence of structures	**Offshore:** The future addition of up to 3,113 new WTG and OSS foundations on the Mid-Atlantic OCS could result in hydrodynamic and artificial reef effects that influence finfish community structure in and near the project footprints. Those changes could influence fish community structure within the GAA in the future, but the likelihood, nature, and significance of these potential changes are difficult to predict and a topic of ongoing research. Artificial structures may also provide opportunities for range expansion by invasive species in conjunction with range shifts due to climate change (Degraer et al. 2020; Langhamer 2012; Schulze et al. 2020). Overall, these effects would range in significance from **minor** adverse for some species to **moderate** beneficial for others.	**Offshore:** The installation of up to 102 offshore structures in the form of monopile foundations with associated scour protection would result in the direct disturbance of finfish. The extent of exposure would vary by species and habitat association. Some individual finfish would unavoidably be injured or killed, but the number of individuals affected would be insignificant relative to the size of the population, and the resource would recover completely without additional mitigation. Residual short- to long-term impacts from construction would continue to affect approximately 6,400 additional acres of benthic habitat not otherwise altered by the presence of structures. The time required for functional recovery would vary by habitat type, with soft-bottomed habitats recovering relatively quickly, whereas impacts to large-grained complex and complex benthic habitats could persist for several years. Therefore, effects to finfish and their habitats from Project construction would be **minor** adverse.	**Offshore:** A comparison of the benthic habitat disturbance footprints for foundation installation under the different configurations of Alternatives C through F and the Proposed Action is provided in Table 3.6-4, Table 3.6-11, Table 3.16-12, and Table 3.6-13 in Section 3.6. Implementation of Alternative F in conjunction with Alternatives C, D, and E is estimated to further reduce seafloor disturbance for these alternatives by up to 8% (Alternative C), 21.5% (Alternative D), and 8% (Alternative E). Non-mobile life stages of finfish within these respective footprints would be exposed to displacement, behavioral disturbance, crushing, and burial effects. Although these alternatives would result in slightly less area exposed to potentially harmful effects, construction impacts would not change relative to the Proposed Action and would be **minor** adverse. Once operational, Alternatives C through F would result in long-term to permanent changes in benthic habitat composition and structure similar in nature to the Proposed Action but differing in extent and distribution. Notably, Alternative C would result in less extensive impacts to large-grained complex and complex habitats in both Zones RWF 1 and 2 than the Proposed Action and Alternatives D and E. The complex habitats within Zones RWF 1 and 2 support several species of managed finfish and spawning cod (Van Hoeck et al. 2023) (see Section 3.13.2.4.1 and Figure 3.13-3). The new offshore structures would also cause localized hydrodynamic effects that would influence primary and secondary productivity within and around this artificial reef, and result in broader-scale hydrodynamic effects that could alter how the pelagic eggs and larvae of some finfish species are dispersed across the northern Mid-Atlantic Bight. This could lead to negative, positive, or neutral effects on EFH species that rely on these dispersal patterns, varying by species. The reef effect would alter biological community structure, producing an array of effects on finfish. Those effects could be beneficial or adverse, varying by species. On balance, operational effects to finfish would range from **moderate** adverse to **moderate** beneficial, varying by species and depending on their ability to exploit new habitats created by the placement of artificial structures. Alternatives C through F would produce similar hydrodynamic and reef effects on finfish to the Proposed Action, but those effects would be reduced in extent because fewer structures would be installed. Reef and hydrodynamic effects would be distributed differently, based on the alternative configuration selected, and insufficient information is available to determine if this would result in substantive differences in effects to finfish between alternatives. Operational effects to finfish would range from **moderate** adverse to **moderate** beneficial, varying by species and depending on their ability to exploit new habitats created by the placement of artificial structures. Similarly, impacts generated during decommissioning would be of similar intensity as those generated under the Proposed Action but reduced in extent and duration, ranging from **minor** to **moderate** adverse depending on the species exposed. Individual finfish could be injured or killed during structure removal, the fish community formed around artificial structures would be dispersed, and individuals that are unable to locate new suitable habitats might not survive.				**Offshore:** Implementation of Alternative G is estimated to reduce seafloor disturbance from the Proposed Action and Alternatives D, E, and F, including sensitive habitats important to Atlantic cod and several other managed finfish. Non-mobile life stages of finfish within these respective footprints would be exposed to displacement, behavioral disturbance, crushing, and burial effects. Although this alternative would result in slightly less area exposure to potentially harmful effects, construction impacts would not change relative to the Proposed Action and would be **minor** adverse. Once operational, Alternative G would result in long-term to permanent changes in benthic habitat composition and structure similar in nature to the Proposed Action but differing in extent and distribution. Notably, Alternative G would result in less extensive impacts to large-grained complex and complex habitats on Cox Ledge than the Proposed Action and Alternatives D, E, and F. Alternative G would result in slightly more permanent impacts from structure presence in large-grained complex and complex habitat than Alternatives C1 and C2 (2.7 to 18.6 additional acres, depending on the configuration selected). These habitats are used by several managed finfish, including spawning Atlantic cod, which emerging data indicate is occurring primarily within Zone RWF 1 (Van Hoeck et al. 2023).

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		During operations, the potential effects to finfish and their habitats resulting from the presence of structures are likely to vary by species. The presence of foundations, scour protection, and cable protection would permanently alter the composition and structure of approximately 221 acres of benthic habitat. The available evidence suggests that some demersal fish species are likely to benefit from increased habitat structure and biological productivity, whereas pelagic fishes may also benefit to a lesser extent. However, considerable uncertainty remains about the broader effects of this type of habitat alteration at population scales (Degraer et al. 2020). The Proposed Action is relatively small in scale compared to existing, pending, and planned wind farm developments, suggesting that broader population effects from this one facility are unlikely. Hydrodynamic effects caused by the presence of the wind farm could alter dispersal patterns for pelagic eggs and larvae, which could influence the productivity of some spawning fish populations. Modeling of hydrodynamic effects on representative fish species indicates that any such effects are likely to be localized and not biologically significant at population scales (Johnson et al. 2021). This modeling effort did not consider potential effects on fish stocks, such as Atlantic cod, that spawn in specific locations. However, insufficient information is available to determine the source populations of cod larvae and juveniles occurring in Southern New England waters, and it is uncertain if the area is fully supported by self-recruitment (NEFMC 2022). In theory, hydrodynamic effects on these species could be more significant, but the available information does not suggest that such effects are likely. Hydrodynamic and reef effects could become more significant when combined with those from other planned offshore wind energy projects in the future. On this basis, habitat alteration on finfish resulting from the Proposed Action is expected to be long term in duration and **minor** beneficial to **moderate** adverse in significance.	Alternatives C through F are comparable in scale to several of the offshore renewable energy projects planned in the GAA. BOEM estimates the Proposed Action and other planned future projects will result in the development of 3,146 to 3,183 WTG and OSS foundations in the finfish GAA. Depending on how they are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential biological significance of broader cumulative effects on finfish. Cumulative effects could be beneficial or adverse, varying by species, and would likely range from **minor** to **moderate** adverse in terms of overall impact.				The new offshore structures would also cause localized hydrodynamic effects that would influence primary and secondary productivity within and around this artificial reef, and broader-scale hydrodynamic effects that could alter how the pelagic eggs and larvae of some finfish species are dispersed across the northern Mid-Atlantic Bight. This could lead to negative, positive, or neutral effects on EFH species that rely on these dispersal patterns, varying by species. The reef effect would alter biological community structure, producing an array of effects on EFH species. Those effects could be beneficial or adverse, varying by species. Alternative G would produce similar hydrodynamic and reef effects on finfish to those described for the Proposed Action, but those effects would be reduced in extent because fewer structures would be installed. Operational effects to finfish would range from **moderate** adverse to **moderate** beneficial, varying by species and depending on their ability to exploit new habitats created by the placement of artificial structures. Similarly, impacts generated during decommissioning would be of similar intensity as those generated under the Proposed Action but reduced in extent and duration, ranging from **minor** to **moderate** adverse depending on the species exposed. Individual finfish could be injured or killed during structure removal, the fish community formed around artificial structures would be dispersed, and individuals that are unable to locate new suitable habitats might not survive.

Impact-Producing Factor	**No Action Alternative**	**Alternative B (Proposed Action) up to 100 WTGs**	**Alternative C (Habitat Alternative) 64–65 WTGs**	**Alternative D (Transit Alternative) 78 to 93 WTGs**	**Alternative E (Viewshed Alternative) 64–81 WTGs**	**Alternative F (Higher Capacity Turbine Alternative) 56 WTGs**	**Alternative G (Preferred Alternative) 65 WTGs**
		The Proposed Action includes regular inspections of the RWF to identify and remove derelict fishing gear and other trash and debris. Other future projects are expected to include similar measures in their O&M plans, creating an effective mechanism for identifying and removing derelict fishing gear and other dangerous marine debris from the GAA. Collectively, the Proposed Action when combined with past, present, and reasonably foreseeable projects would result in **negligible** to **minor** beneficial cumulative effects on finfish from removal of derelict fishing gear and marine debris. Cumulative effects are likely to vary by species and could be positive or negative, Cumulative impacts from hydrodynamic and artificial reef effects would likely range from **moderate** beneficial to **moderate** adverse in significance, whereas cumulative impacts from debris removal are likely to be **minor** beneficial. Collectively, cumulative impacts from the combined reef and hydrodynamic effects of multiple offshore wind energy projects on finfish could be positive or negative, varying by species, and would likely range from **moderate** adverse to **moderate** beneficial in significance, varying by species.					Alternative G is comparable in scale to several of the offshore renewable energy projects planned in the GAA. BOEM estimates that Alternative G and other planned future projects will result in the development of 3,155 WTG and OSS foundations in the finfish GAA. Depending on how they are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential biological significance of broader cumulative effects on finfish. Cumulative effects could be beneficial or adverse, varying by species, and would likely range from **minor** to **moderate** adverse in terms of overall impact.
Sediment deposition and burial	**Offshore:** Although suspended sediment and burial effects are an unavoidable consequence of offshore wind energy construction, O&M, and decommissioning, these effects would be limited in extent and short term in duration, effectively ending once the sediments have resettled. Individual finfish could be adversely affected, but the number of individuals impacted and the duration of effects would be unlikely to adversely affect any finfish species at the population level at the scale of the GAA and would therefore be **minor** adverse.	**Offshore:** The Project would result in short-term, elevated levels of suspended sediment near major bed-disturbing activities like cable installation. Given the short-term nature of the impact and the limited extent of significant burial effects relative to the amount of habitat available, burial effects on benthic eggs and larvae would be short term and expected to recover without remedial or mitigating action and therefore **minor** adverse. Cable protection maintenance would produce similar effects on finfish as those described for Project construction, although they would be reduced in extent and spread out over time. The resulting effects from O&M and decommissioning would therefore be **minor** adverse.	**Offshore:** See Section 3.13.2.4.1 for construction impacts. Cable protection maintenance would produce similar effects on finfish as those described for Project construction, although they would be reduced in extent and spread out over time. These effects would range from short-term behavioral disturbance of benthic fauna and other finfish accustomed to naturally high rates of sediment deposition, to mortality of benthic eggs and fish subject to burial effects greater than 0.4 inch (10 mm). The IAC, OSS-link cable, and RWEC would be removed from the seafloor during Project decommissioning. Removal of cable protection and extraction of the cable from the seafloor would disturb sediments, releasing TSS into the water column. The resulting adverse effects from O&M and decommissioning would therefore be **minor** adverse**.** Alternatives C through F would result in localized short-term **minor** adverse sediment deposition and burial effects on finfish. Short-term burial effects exceeding 10 mm would occur over an estimated 7,150 acres within the GAAs for finfish. Construction-related disturbance and suspended sediment effects would impact habitat and could disturb, injure, or kill finfish.				**Offshore:** See Section 3.13.2.4.1 for construction impacts.

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		Cumulative impacts would be more extensive and distributed across offshore WEAs within the GAA. However, these effects would be short term in duration and are not likely to have measurable population-level effects on any finfish species; therefore, cumulative effects from sediment deposition and burial would be **minor** adverse.	Alternatives C through F in combination with future offshore wind projects would generate similar sediment deposition and burial effects to those described for the Proposed Action. Juvenile and adult finfish associated with benthic habitats are unlikely to be significantly affected by sediment deposition at the burial depths anticipated, but benthic eggs and larvae of some species could be harmed. Impacts would be short term and would have a limited extent of significant burial effects relative to the amount of habitat available. Cumulative short-term impacts from all planned and future projects are not likely to have measurable population-level effects on any finfish species; therefore, cumulative effects from sediment deposition and burial would be **minor** adverse**.**				Cable protection maintenance would produce similar effects on finfish as those described for Project construction, although they would be reduced in extent and spread out over time. These effects would range from short-term behavioral disturbance of benthic fauna and other finfish accustomed to naturally high rates of sediment deposition, to mortality of benthic eggs and fish subject to burial effects greater than 0.4 inch (10 mm). The IAC, OSS-link cable, and RWEC would be removed from the seafloor during Project decommissioning. Removal of cable protection and extraction of the cable from the seafloor would disturb sediments, releasing TSS into the water column. The resulting adverse effects from O&M and decommissioning would therefore be **minor** adverse**.** Alternative G would result in localized short-term **minor** adverse sediment deposition and burial effects on finfish. Short-term burial effects exceeding 10 mm would occur over an estimated 6,578 acres within the GAAs for finfish. Construction-related disturbance and suspended sediment effects would impact habitat and could disturb, injure, or kill finfish. Alternative G in combination with future offshore wind projects would generate similar sediment deposition and burial effects to those described for the Proposed Action. Juvenile and adult finfish associated with benthic habitats are unlikely to be significantly affected by sediment deposition at the burial depths anticipated, but benthic eggs and larvae of some species could be harmed. Impacts would be short term and would have a limited extent of significant burial effects relative to the amount of habitat available. Cumulative short-term impacts from all planned and future projects are not likely to have measurable population-level effects on any finfish species; therefore, cumulative effects from sediment deposition and burial would be **minor** adverse**.**

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EFH							
Accidental releases and discharges	**Offshore:** Offshore wind energy development could result in the accidental release of water quality contaminants or trash/debris, which could lead to an increase in debris and pollution in the GAA. However, compliance with BOEM and USCG requirements would effectively minimize releases of trash and debris. Therefore, effects on EFH would be **negligible** adverse.	**Offshore**: BOEM prohibits the discharge or disposal of solid debris into offshore waters during any activity associated with the construction and operation of offshore energy facilities (30 CFR 250.300). The USCG similarly prohibits the dumping of environmentally damaging trash or debris (MARPOL, Annex V, Public Law 100–220 (101 Stat. 1458)). Given these restrictions, the risk to EFH species and habitats from trash and debris from the Proposed Action would be **negligible** adverse. The Project would follow strict oil spill prevention and response procedures during all Project phases, effectively avoiding the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, **minor** to **moderate** adverse effects to EFH species and their habitats could result. BOEM estimates that the Project when combined with other offshore wind projects would result in approximately 34 million gallons of coolants, fuel, oils, and lubricants cumulatively stored within WTGs and OSSs within the GAA. All vessels associated with the Proposed Action and other offshore wind projects would comply with USCG requirements for the prevention and control of oil and fuel spills. For this reason, the Proposed Action when combined with other past, present, and reasonably foreseeable projects would result in **negligible** to **minor** adverse cumulative impacts.	**Offshore:** Similar to the Proposed Action, given the restrictions imposed by BOEM and the USCG, the risk to EFH from trash and debris from Alternatives C through F is negligible adverse. Moreover, Alternatives C through F would similarly include inspection of offshore structures and removal of derelict fishing gear and other accumulated debris. This would provide a mechanism for removing potentially harmful marine debris from the environment and would constitute a **minor** beneficial effect on finfish. Similarly, the same strict oil spill prevention and response procedures would apply, effectively avoiding the risk of large-scale environmentally damaging spills under reasonably foreseeable circumstances. In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, minor to moderate adverse effects to EFH could result. Alternatives C through F would slightly reduce total chemical uses relative to the Proposed Action, but this effect would be small in comparison to projected chemical use on the Mid-Atlantic OCS overall. All future offshore energy development projects would comply with BOEM and USCG regulations that prohibit dumping of trash and debris and require measures to avoid and minimize accidental spills. These regulations minimize, but not completely eliminate, the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, **minor** to **moderate** adverse cumulative effects would occur.				**Offshore:** Similar to the Proposed Action, given the restrictions imposed by BOEM and the USCG, the risk to EFH from trash and debris from Alternative G is negligible adverse. Moreover, Alternative G would similarly include inspection of offshore structures and removal of derelict fishing gear and other accumulated debris. This would provide a mechanism for removing potentially harmful marine debris from the environment. This would constitute a **minor** beneficial effect on finfish. Similarly, the same strict oil spill prevention and response procedures would apply, effectively avoiding the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, minor to moderate adverse effects to EFH could result. Alternative G would slightly reduce total chemical uses relative to the Proposed Action, but this effect would be small in comparison to projected chemical use on the Mid-Atlantic OCS overall. All future offshore energy development projects would comply with BOEM and USCG regulations that prohibit dumping of trash and debris and require measures to avoid and minimize accidental spills. These regulations minimize, but not completely eliminate, the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, **minor** to **moderate** adverse cumulative effects would occur.
Anchoring and new cable	**Offshore:** Offshore wind energy facility construction would involve direct disturbance of the seafloor leading to direct impacts on finfish. In general,	**Offshore:** Seafloor disturbance from various overlapping cable installation activities, including boulder relocation, jet plow trenching for cable installation, and placement of cable protection,	**Offshore:** The potential impact to EFH related to crushing and burial during construction of Alternatives C through F would be the same as or similar to the Proposed Action and would have a **minor to moderate** adverse impact on EFH.				**Offshore:** The potential impact to EFH related to crushing and burial during construction of Alternative G would be the same as or similar to the Proposed Action

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emplacement/ maintenance	these effects would be localized to the disturbance footprint and vicinity. The specific type and extent of habitat conversion and resulting effects on finfish would vary depending on the project design, species present, and site-specific conditions. Therefore, the impacts from this disturbance on finfish would be **minor** adverse.	could impact up to 3,451 acres distributed throughout the RWF and RWEC maximum work areas. Additionally, 10% of cable protection could need to be replaced over the life of the Project. EFH within these construction footprints would be directly exposed to disturbance. Short-term disturbance impacts on soft-bottom benthic habitats would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could be long term to permanent. Long-term impacts to habitat-forming organisms in complex habitats would require several years to recover full habitat function. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat type. Although habitat structure may be altered, habitat composition in the affected areas would recover to functional condition over the life of the Project. On balance, these impacts would constitute short-term to permanent adverse impacts on EFH, but those impacts would not result in a biologically significant change in the overall extent of available EFH habitat within the Lease Area and RWEC corridor. Therefore, these impacts would be **minor** to **moderate** adverse. BOEM estimates a cumulative total of 11,631 acres of anchoring and mooring-related disturbance and 105,390 acres of cabling-related disturbance for the Proposed Action plus all other future offshore wind projects within the finfish and EFH GAA. When combined with other past, present, and reasonably foreseeable actions, the Proposed Action would result in **moderate** adverse cumulative impacts.	Alternatives C through F would reduce the total length of IAC relative to the Proposed Action, meaning that the total amount of cable protection and maintenance-related impacts on EFH would decrease commensurately. The resulting adverse effects from O&M and decommissioning would be similar in nature but lesser in magnitude than those from Project construction, O&M, and decommissioning and would therefore be **minor** adverse. Alternatives C through F would result in localized, minor to moderate impacts to EFH through seafloor disturbance from cable installation and vessel anchoring and mooring. Of Alternatives C through F, Alternative C would have the least overall potential disturbance to EFH of these four alternatives. The surface occupancy would noticeably reduce the cumulative impact acreage across Alternatives C through F relative to the Proposed Action, but the nature, duration, and general scope of effects would otherwise be similar. Impacts on soft-bottom benthic habitats and associated finfish species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take a several years to recover to full habitat function. Therefore, Alternatives C through F when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to EFH.				and would have a **minor to moderate** adverse impact on EFH. Alternative G would reduce the total length of IAC relative to the Proposed Action, meaning that the total amount of cable protection and maintenance-related impacts on EFH would decrease commensurately. Notably, Alternative G would result in less extensive impacts to large-grained complex and complex habitats important to several EFH species compared to the Proposed Action. Under the base configuration of Alternative G, 6.7% and 25.9% of an estimated 4,291 acres of impacts would occur in large-grained complex and complex habitats, respectively, compared to 14.9% and 27.3% of 5.247 acres, respectively. Alternatives G1 through G3 would reduce benthic habitat impacts by an additional 479 to 488 acres relative to the base Alternative G. The resulting adverse effects from O&M and decommissioning would be similar in nature but lesser in magnitude than those resulting from Project construction, O&M, and decommissioning and would therefore be **minor** adverse. Alternative G would result in localized, minor to moderate impacts to EFH through seafloor disturbance from cable installation and vessel anchoring and mooring. The surface occupancy would noticeably reduce the cumulative impact acreage across Alternative G relative to the Proposed Action, but the nature, duration, and general scope of effects would otherwise be similar. Disturbance impacts to soft-bottom benthic habitats and associated fish species would be short term, and these habitats and species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could be long term to permanent. Long-term impacts to habitat-forming organisms in complex habitats would require several years to recover full habitat function. Permanent habitat impacts would result where seafloor preparation and placement of scour

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							protection result in conversion to a new habitat type. Although habitat structure may be altered, habitat composition in the affected areas would recover to functional condition over the life of the Project. These effects would be similar in nature but reduced in extent relative to the Proposed Action. Alternative G would result in localized minor to moderate adverse impacts to EFH habitat through an estimated 3,204 acres of anchoring and mooring-related disturbance and 3,452 acres of cabling-related seafloor disturbance within the EFH habitat GAA. Actual anchoring requirements have not been fully specified, and the former represents an overestimate of probable effects. Further, an appreciable portion of anchoring and cable installation impacts would overlap. Therefore, total acres of EFH habitat impacted by this IPF would likely be smaller than the total 6,656 acres from these two sources. Therefore, Alternative G when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to EFH.
Climate change	**Offshore:** Global climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These trends are expected to continue under the No Action Alternative. The intensity of impacts on EFH resulting from climate change are uncertain and will vary by species but on the whole are anticipated to be minor to **moderate** adverse.	**Offshore:** The types of impacts from global climate change described for the No Action Alternative would occur under the Proposed Action, but the Proposed Action could also contribute to a long-term net decrease in GHG emissions. When combined with other past, present, and reasonably foreseeable actions, the Proposed Action would have a noticeable effect on GHG emissions. Regardless, climate change will likely result in **moderate** adverse cumulative impacts on EFH species and habitats.	**Offshore:** Climate change–related impacts to EFH under Alternatives C through F would be the same as the Proposed Action. Ongoing trends associated with climate change, including increases in water temperature, ocean acidification, changes in runoff and circulation patterns, and species range shifts, are expected to continue. The intensity of climate change cumulative impacts on EFH is uncertain and is likely to vary considerably between species, resulting in **moderate** adverse effects regardless of the alternative selected. When combined with other past, present, and reasonably foreseeable actions, Alternatives C through F would have a noticeable effect on GHGs emissions. However, projected climate change impacts on EFH would likely remain **moderate** adverse regardless of the alternative selected.				**Offshore:** Climate change–related impacts to EFH under Alternative G would be the same as the Proposed Action. Ongoing trends associated with climate change, including increases in water temperature, ocean acidification, changes in runoff and circulation patterns, and species range shifts, are expected to continue. The intensity of climate change cumulative impacts on EFH is uncertain and is likely to vary considerably between species, resulting in **moderate** adverse effects regardless of the alternative selected. When combined with other past, present, and reasonably foreseeable actions, Alternative G would have a noticeable effect on GHGs emissions. However, projected climate change impacts on EFH will likely remain **moderate** adverse regardless of the alternative selected.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
EMF	**Offshore:** Under the No Action Alternative, up to 13,469 miles of cable installation would be added in the GAA, producing EMF in the immediate vicinity of each cable during operations. Because measurable EMF effects are generally limited to within tens of feet of cable corridors, these future activities would not affect existing EMF conditions unless a transmission cable were routed directly through the GAA. Accordingly, EMF effects from future activities would most likely be **negligible** to **minor** adverse if HVAC is used, or **moderate** adverse if HVDC is used.	**Offshore:** The effects of EMF and associated substrate heating on EFH species and habitats would be the same as those described previously for finfish, wherein findings indicate that long-term EMF effects on EFH would likely be **minor** adverse along most of the lengths of the IAC, OSS-link cable, and RWEC. BOEM anticipates that future offshore wind energy projects in the GAA would use HVAC transmission and apply similar design measures to avoid and minimize EMF effects on the environment. Cumulative EMF impacts resulting from the Proposed Action in combination with past, present, and reasonably foreseeable activities would therefore be **minor** adverse if HVAC is used, or **moderate** adverse if HVDC is used.	**Offshore:** Alternatives C through F would result in similar EMF impacts on EFH to those described previously for the Proposed Action, but those impacts would be reduced in extent, and the total area exposed would vary depending on the configuration selected. Long-term EMF effects on EFH would likely be **minor** adverse along most of the lengths of the IAC, OSS-link cable, and RWEC. Under Alternatives C through F, EMF effects would combine with those generated by the 13,717 miles of new and existing transmission cables from the other new offshore wind facilities planned on the Mid-Atlantic OCS as well as other existing transmission cables. These cumulative effects would be similar in nature to those for the No Action Alternative but would occur over a larger area, as determined by the broader Project footprint. Cumulative impacts to EFH would therefore be **minor** adverse if HVAC is used, or **moderate** adverse if HVDC is used.				**Offshore:** Alternative G would result in similar EMF impacts on EFH to those described for the Proposed Action, but those impacts and the total area exposed would be reduced in extent. Long-term EMF effects on EFH would likely be **minor** adverse along most of the lengths of the IAC, OSS-link cable, and RWEC. Under Alternative G, EMF effects would combine with those generated by the 13,717 miles of new and existing transmission cables from the other new offshore wind facilities planned on the Mid-Atlantic OCS as well as other existing transmission cables. These cumulative effects would be similar in nature to those for the No Action Alternative but would occur over a larger area. Cumulative impacts to EFH would therefore be **minor** adverse if HVAC is used, or **moderate** adverse if HVDC is used.
Noise	**Offshore:** Several proposed offshore wind projects could be developed on the Mid-Atlantic OCS between 2022 and 2030, including some projects near the RWF (see Appendix E), and would result in noise-generating activities. As stated for finfish, future projects could result in **negligible** to **moderate** adverse effects to EFH.	**Offshore:** The construction and installation of the RWF would involve activities that would generate underwater noise exceeding established thresholds for mortality and permanent or short-term injury, TTS, and behavioral effects. Underwater noise would render the affected habitats unsuitable for EFH species over the short term and could have short-term impacts on prey availability for EFH species. The extent, duration, and severity of noise effects on EFH would vary depending on the noise source and the sensitivity of the affected EFH species and their prey to noise impacts during their lifecycle, but would be likely range from **minor** to **moderate** adverse. BOEM anticipates that underwater noise generated by operations of the WTGs and O&M-related vessels, as well as decommissioning, would result in effects considered **negligible** to **minor** adverse, based on the impacts described previously for finfish. Localized and short-term to permanent cumulative impacts from the Proposed Action would combine with similar localized impacts from other past, present, and reasonably	**Offshore:** The construction and installation of Alternatives C through F would generate underwater noise exceeding established thresholds for mortality and permanent or short-term injury, TTS, and behavioral effects similar to those described for finfish. Underwater noise would render the affected habitats unsuitable for EFH species over the short term and could have short-term impacts on prey availability for EFH species. The extent, duration, and severity of noise effects on EFH would vary depending on the noise source and the sensitivity of the affected EFH species and their prey to noise impacts during their life cycle. Alternatives C through E would reduce the number of foundations and extent of IAC relative to the Proposed Action, with a commensurate reduction in associated construction noise impacts. Alternative C would provide the greatest overall reduction in construction activity and associated noise effects in identified Atlantic cod spawning habitat (Van Hoeck et al. 2023) compared to the Proposed Action. Combining Alternatives C and F would result in further reductions of noise impacts due to the reduction in turbines and associated reductions in activities that could impact Atlantic cod (construction and O&M-related noise, seafloor preparation, etc.). The underwater noise effects would be the same or similar as those described above for finfish and would be likely range from **minor** to **moderate** adverse. Underwater noise effects on finfish resulting from O&M and decommissioning of Alternatives C through F would be similar in magnitude but reduced in extent relative to those described for the Proposed Action and therefore **negligible** to **minor** adverse, based on the impacts described previously for finfish. BOEM estimates that underwater noise from the construction of up to 16 other offshore wind facilities would result in short-term injury or behavioral effects on finfish over a cumulative area. Vessel noise from construction and installation, as well as O&M activities, could cause startle and avoidance responses in fish but would not cause injury. Periodic noise from O&M vessels and continuous or near-continuous WTG operational noise exceeding behavioral effects				**Offshore:** The construction and installation of Alternative G would generate underwater noise exceeding established thresholds for mortality and permanent or short-term injury, TTS, and behavioral effects similar to those described for the Proposed Action but reduced in extent and duration. Underwater noise would render the affected habitats unsuitable for EFH species over the short term and could have short-term impacts on prey availability for EFH species. The extent, duration, and severity of noise effects on EFH would vary depending on the noise source and the sensitivity of the affected EFH species and their prey to noise impacts during their life cycle. Alternatives G1 to G3 would further reduce construction activity and associated noise effects due to the reduction in turbines and associated reductions in activities that could impact Atlantic cod (construction and O&M-related noise, seafloor preparation, etc.), relative to the Proposed Action, leading to less extensive impacts on identified Atlantic cod

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
		foreseeable activities, resulting in **negligible** to **moderate** adverse effects on EFH.	thresholds for fish would occur within a few hundred feet of each source (HDR 2019). These effects would occur over the life of the Project through decommissioning. These localized and short-term to permanent cumulative impacts from Alternatives C through F would combine with similar localized impacts from other past, present, and reasonably foreseeable activities, resulting in **negligible** to **minor** adverse effects on EFH and finfish species and their habitats.				spawning habitat (Van Hoeck et al. 2023) compared to the Proposed Action. The underwater noise effects would be the same or similar as those described above for finfish and would be likely range from **minor** to **moderate** adverse. Underwater noise effects on finfish resulting from O&M and decommissioning of Alternative G would be similar in magnitude but reduced in extent relative to those described for the Proposed Action and therefore **negligible** to **minor** adverse, based on the impacts described previously for finfish. However, the potential for more significant operational noise effects on EFH species such as cod is uncertain. BOEM estimates that underwater noise from the construction of up to 16 other offshore wind facilities would result in short-term injury or behavioral effects on finfish over a cumulative area. Vessel noise from construction and installation, as well as O&M activities, could cause startle and avoidance responses in fish but would not cause injury. Periodic noise from O&M vessels and continuous or near-continuous WTG operational noise exceeding behavioral effects thresholds for fish would occur within a few hundred feet of each source (HDR 2019). These effects would occur over the life of the Project through decommissioning. These localized and short-term to permanent cumulative impacts from Alternative G would combine with similar localized impacts from other past, present, and reasonably foreseeable activities, resulting in **negligible** to **minor** adverse effects on EFH and finfish species and their habitats.
Bycatch	**Offshore**: A range of monitoring activities have been proposed to evaluate the short-term and long-term effects of existing and planned offshore wind development on biological resources and are also likely for future wind energy projects on the OCS. Some of these	**Offshore:** Revolution Wind is proposing to implement the FRMP as part of the Proposed Action (Revolution Wind and Inspire Environmental 2023). The FRMP employs a variety of survey methods to evaluate the effect of RWF construction and operations on selected finfish	**Offshore:** The effects to EFH from Alternatives C through F are anticipated to be the same as or similar to the Proposed Action.				**Offshore:** The effects to EFH from Alternative G are anticipated to be the same as or similar to the Proposed Action.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	monitoring activities are likely to affect EFH through direct sampling and the potential for bycatch and/or damage by sample collection gear. Research and monitoring activities related to offshore wind would not necessarily result in an increase in bycatch-related impacts, although the distribution of those impacts could change. Given this, any bycatch-related impacts on EFH would be **negligible** to **minor** adverse, and short term in duration.	species and on benthic habitat structure and function. Although the FRMP would result in unavoidable impacts to EFH species and their habitats, the extent of habitat disturbance and the number of organisms affected would be small in comparison to commercial and recreational fishing mortality and would not measurably impact the viability of any species at the population level. Given this, all habitat impacts from FRMP implementation would be short term in duration. The intensity and duration of impacts anticipated from FRMP implementation would constitute a **minor** cumulative effect on finfish. These impacts would be offset by an improved understanding of the effects of offshore wind development on regional fish species and their habitats. This could in turn contribute to improved management of EFH species and their habitats.					
Presence of structures	**Offshore:** The future addition of up to 3,113 new WTG and OSS foundations on the Mid-Atlantic OCS could result in hydrodynamic and artificial reef effects that influence finfish community structure in and near the project footprints, resulting in effects that would be permanent and **moderate** beneficial for some species from habitat conversion and have **minor** adverse effects due to permanent habitat loss.	**Offshore:** The installation of 102 monopile foundations with associated scour protection would result in direct disturbance to EFH species and their habitats. The ongoing presence of monopiles, their foundations, and scour protection during Project O&M within the RWF and RWEC would create an artificial reef effect as well as hydrodynamic effects. The reef effect would alter biological community structure, producing an array of effects on EFH species. Those effects could be beneficial or adverse, varying by species. Although localized effects are possible, ecosystem modeling studies of a European wind farm showed little difference in key food web indicators before and after construction and installation (Raoux et al. 2017). Thus, large-scale food web shifts are not expected due to the installation of WTGs and conversion of pelagic habitat to hard surface and would be expected to result in **negligible** to **minor** adverse or beneficial effects, varying by species. Hydrodynamic effects would influence primary and secondary productivity at local scales within and around this artificial reef, and dispersal patterns for the pelagic eggs and larvae of some finfish species at larger scales across the northern Mid-Atlantic Bight. This could lead to negative,	**Offshore:** Similar to the Proposed Action, Alternatives C through F would result in the long-term alteration of water column and seafloor habitats due to structure presence, resulting in a diversity of effects on EFH. Monopile foundations and other hard surfaces installed would create the same type of habitat impacts and artificial reef effects, but those effects would be less extensive and distributed differently in comparison to the Proposed Action. Insufficient information is available to determine how the changes in Project configuration under Alternatives C through F could alter the extent and significance of potential hydrodynamic effects of EFH species and habitats. Alternatives C through F would include inspection offshore structures and removal of derelict fishing gear and other accumulated debris. This would provide a mechanism for removing potentially harmful marine debris from the environment. This would constitute a minor beneficial cumulative effect to EFH. BOEM estimates that Alternatives C through F and other planned future projects would result in the development of 3,146 to 3,183 WTG and OSS foundations in the EFH GAA. Depending on how these are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential significance of broader cumulative effects on finfish and EFH. Collectively, cumulative impacts from the combined reef and hydrodynamic effects of multiple offshore wind energy projects on EFH could be positive or negative, varying by species, and would likely range from **moderate** adverse to **moderate** beneficial in significance, varying by species.				**Offshore:** Similar to the Proposed Action, Alternative G would result in the long-term alteration of water column and seafloor habitats due to structure presence, resulting in a diversity of effects on EFH. Alternative G would result in the long-term alteration of EFH habitat composition on approximately 189.7 acres of seafloor. That total would comprise approximately 2.3 and 54.3 acres of seafloor displaced by foundations and associated scour protection, respectively; 5.7 acres of cable protection system impacts extending beyond the scour protection footprint; and 120.5 acres affected by cable protection. The foundations would effectively displace EFH habitat, with each foundation replacing 0.03 to 0.04 acre of seafloor with a vertical structure extending from the seafloor to the surface. Monopile foundations and other hard surfaces installed would create the same type of habitat impacts and artificial reef effects, but those effects would be less extensive and distributed differently in comparison to the Proposed Action. Notably, Alternative G would result in less extensive impacts to large-grained complex and complex habitats important to several EFH species.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
		positive, or neutral effects on EFH species that rely on these dispersal patterns, varying by species. These effects would vary from **negligible** to **moderate** adverse in significance, varying by species. BOEM estimates that the Proposed Action and other planned future projects would result in the development of 3,190 WTG and OSS foundations in the EFH GAA. Depending on how these are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential significance of broader cumulative effects on finfish and EFH species and habitat. Effects could be beneficial or adverse, varying by species. Collectively, cumulative impacts from the combined reef and hydrodynamic effects of multiple offshore wind energy projects on EFH could be positive or negative, varying by species, and would likely range from **moderate** adverse to **moderate** beneficial in significance, varying by species.					Insufficient information is available to determine how the changes in Project configuration under Alternative G could alter the extent and significance of potential hydrodynamic effects of EFH species and habitats. Alternative G would include inspection of offshore structures and removal of derelict fishing gear and other accumulated debris. This would provide a mechanism for removing potentially harmful marine debris from the environment. This would constitute a **minor** beneficial cumulative effect to EFH. BOEM estimates that Alternative G and other planned future projects would result in the development of 3,155 WTG and OSS foundations in the EFH GAA. Depending on how these are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential significance of broader cumulative effects on finfish and EFH. Collectively, cumulative impacts from the combined reef and hydrodynamic effects of multiple offshore wind energy projects on EFH could be positive or negative, varying by species, and would likely range from **minor** to **moderate** adverse to **moderate** beneficial in significance, varying by species.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
Sediment deposition and burial	**Offshore:** As previously noted, under the No Action Alternative, up to 13,469 miles of cable installation would be added in the GAA. These effects would be short term in duration, effectively ending once the sediments have resettled, resulting in short-term **minor** adverse effects on finfish.	**Offshore:** The Project would result in short-term, elevated levels of suspended sediment near major bed-disturbing activities like cable installation. Given the short-term nature of the impact and the limited extent of significant burial effects relative to the amount of habitat available, however, sediment deposition and burial effects on EFH habitat would be short term and expected to recover without remedial or mitigating action and therefore would be **minor** adverse. Up to 10% of cable protection could be replaced over the life of the Project under the Proposed Action. Cable protection maintenance would produce similar effects on EFH species as those described for Project construction and installation, although reduced in extent and spread out over time. The resulting effects from O&M and decommissioning would therefore be **minor** adverse. Cumulative short-term impacts from all planned and future projects are not likely to have measurable population-level effects on any EFH species; therefore, cumulative effects from sediment deposition and burial would be **minor** adverse**.**	**Offshore:** Alternatives C through F would result in similar sediment deposition and burial impacts on EFH to those described for the Proposed Action, but those impacts would be reduced in extent, and the total area exposed would vary depending on the configuration selected. Although this alternative would result in a slightly smaller area exposed to potential sediment deposition impacts, overall impacts would not change relative to the Proposed Action and would be **minor** adverse. Cable protection maintenance would produce similar **minor** adverse effects on EFH as those described for Project construction, although reduced in extent and spread out over time. These effects would range from short-term sediment deposition and burial effects greater than 0.4 inch (10 mm). The IAC, OSS-link cable, and RWEC would be removed from the seafloor during Project decommissioning. Removal of cable protection and extraction of the cable from the seafloor would disturb sediments, releasing TSS into the water column. Cumulative short-term impacts from all planned and future projects are not likely to have measurable population-level effects on any EFH species; therefore, cumulative effects from sediment deposition and burial would be **minor** adverse**.**				**Offshore:** Alternative G would result in similar sediment deposition and burial impacts on EFH to those described for the Proposed Action, but those impacts would be reduced in extent. Although this alternative would result in a slightly smaller area exposed to potential sediment deposition impacts, overall impacts would not change relative to the Proposed Action and would be **minor** adverse. Cable protection maintenance would produce similar **minor** adverse effects on EFH as those described for Project construction, although reduced in extent and spread out over time. These effects would range from short-term sediment deposition and burial effects greater than 0.4 inch (10 mm). The IAC, OSS-link cable, and RWEC would be removed from the seafloor during Project decommissioning. Removal of cable protection and extraction of the cable from the seafloor would disturb sediments, releasing TSS into the water column. Cumulative short-term impacts from all planned and future projects are not likely to have measurable population-level effects on any EFH species; therefore, cumulative effects from sediment deposition and burial would be **minor** adverse**.**

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3.13.2.2 Alternative A: Impacts of the No Action Alternative on Finfish

3.13.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for finfish (see Section 3.13.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the GAA. These IPFs are described and analyzed in Appendix E1.

3.13.2.2.2 Cumulative Impacts

This section discloses potential finfish impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

Offshore Activities and Facilities

This section discloses potential finfish impacts associated with future offshore wind development. Analysis of impacts associated with ongoing activities and future non–offshore wind activities is provided in Appendix E1. The duration of impacts disclosed for this resource deviate slightly from BOEM guidelines provided in Section 3.3.[40]

Accidental releases and discharges: Offshore wind energy development could result in the accidental release of water quality contaminants or trash/debris, which could theoretically lead to an increase in debris and pollution in the GAA (see Section 3.21 for a characterization of existing water quality conditions). In general, the types of accidental hazardous materials releases associated with marine construction projects consist of fuels, lubricating oils, and other petroleum products. BOEM prohibits the discharge or disposal of solid debris into offshore waters during any activity associated with the construction and operations of offshore wind energy facilities (30 CFR 250.300). The USCG similarly prohibits the dumping of trash or debris capable of posing entanglement or ingestion risk (MARPOL, Annex V, Public Law 100−220 (101 Stat. 1458)). Project proponents would also be required to comply with other state and federal regulations to avoid the unintentional introduction of nonnative species. Compliance with these requirements would effectively minimize releases of trash and debris. Any accidental release of plastic or other solid debris would be highly localized, dissipate quickly, and therefore result in ecologically **negligible** adverse impacts to finfish in relation to baseline plastic pollution levels (Morét-Ferguson et al. 2010).

Increased vessel traffic associated with offshore renewable energy construction presents the potential for the inadvertent introduction of invasive species during discharge of ballast and bilge water. BOEM would require all Project vessels to adhere to existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR 151.2025) and EPA NPDES Vessel General Permit standards, effectively avoiding the likelihood of nonnative species invasions through ballast water discharge. Considering these requirements and the dispersed distribution of planned

[40] NMFS (2021b) recommends the following temporal definitions: short term (less than 2 years); long term (2 years to < life of the Project); permanent (life of the Project).

offshore wind energy facilities, existing water quality trends are likely to continue. The impacts associated with accidental releases and discharges are anticipated to be **negligible** adverse.

Anchoring and new cable emplacement/maintenance: Up to 8,427 acres could be affected by anchoring/mooring activities and 101,381 acres could be affected by cable installation for future offshore wind energy development within the finfish GAA. Anchoring and cable installation activities would involve direct disturbance of the seafloor, leading to direct impacts on benthic habitats used by demersal finfish. These impacts would temporarily degrade some habitats and could change habitat structure and composition in ways that alter habitat suitability for certain species. For example, vessel anchoring in complex or large-grained complex habitats can create troughs in the seafloor that are effectively permanent (HDR 2020), and damage to structure-forming invertebrates on hard substrates can take several years to fully recover (de Marignac et al. 2008). In contrast, anchoring impacts in soft-bottom habitats are expected to fully recover within 18 to 30 months following initial disturbance through natural sediment transport (Daylander et al. 2012) and recolonization by benthic invertebrates from adjacent habitats (Grabowski et al. 2014; HDR 2020).

Finfish within the construction footprint would be exposed to risk of displacement, crushing, and burial during seafloor preparation of cable corridors, cable installation, placement of cable protection, and vessel anchoring. Impacts to large-grained complex and complex benthic habitat from vessel anchoring, cable installation and cable protection, and seafloor preparation for foundation installation could impact managed finfish that use these habitats (e.g., monkfish) and may indirectly disturb important behaviors like spawning. Atlantic cod spawning occurring within other lease areas could be disturbed if anchoring and cable emplacement activities (e.g., grapnel runs and jet plowing) are occurring in proximity. EPMs for ongoing projects, such as using a boulder grab and a work-class remotely operated vehicle boulder skid for most boulder relocations, siting export cables and WTGs to avoid hard-bottom habitats, and developing and implementing construction and O&M anchoring plans, are expected to help minimize impacts and modifications to large-grained complex and complex habitats that support spawning cod and other managed finfish.

Disturbance impacts to soft-bottom benthic habitats and associated fish species would be short term, and these habitats and species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could be long term to permanent. Long-term impacts to habitat-forming organisms in complex habitats would require several years to recover full habitat function. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat type. Although habitat structure may be altered, habitat composition in the affected areas would recover to functional condition over the life of the Project.

Research obtained by BOEM (2023e) suggests that full recovery of habitat function is likely to occur within a decade of disturbance. The study in question compared the community composition and abundance of habitat-forming organisms in heavily fished areas on Georges Bank to reference sites. The findings of this long-term study demonstrated that epifaunal species damaged by repeated exposure to scallop dredging were able to recover to levels that were statistically indistinguishable from unfished reference sites within 6 years. Although some short- and long-term degradation of finfish habitat from anchoring impacts could occur, these impacts would be limited in extent relative to the total amount of habitat available in the finfish GAA. The affected habitats would recover to fully functional condition for finfish without mitigation. Therefore, impacts to finfish from vessel anchoring would be **minor** adverse. Under the No Action Alternative, up to 13,469 miles of cable installation would be added in the GAA for finfish. These activities would result in short- and long-term seafloor profile alterations that are likely to affect both the physical structure of the habitat and habitat-forming invertebrates used by demersal finfish as habitat. Placement of cable protection would introduce human-made hard surfaces to the seafloor, resulting in a long-term change in benthic habitat composition. Short-term alterations would occur in soft-bottom habitats and would result from the flattening of sand and damage to biogenic structures like worm tubes and burrows and depressions formed by fish and invertebrates during seafloor preparation for cable installation. Seafloor preparation in large-grained complex and complex benthic habitats could result in long-term changes in seafloor profile. For example, boulder relocation during seafloor preparation could convert existing complex benthic habitat to heterogeneous complex habitat by creating a furrow of soft-bottom habitat within the larger matrix. Similarly, boulders and cobbles rolled into soft-bottom habitat would constitute a long-term change in the seafloor profile of the affected area. Cable burial would result in short-term disruption to benthic communities through sediment suspension, physical disturbance, physical displacement, and egg and larva entrainment (see Section 3.13.2.2.1). Collectively, these impacts would alter the suitability of the affected habitat for different finfish species, with the effects depending on habitat association. For example, species that associate with soft-bottom substrates (e.g., summer flounder) would gain habitat in areas where boulder relocation exposes swaths of sand and lose habitat where boulder relocation and cable protection replace sandy substrates with new hard surfaces. The affected habitats would eventually recover to full function, and any net losses of habitat suitability for any individual species would be localized minor adverse.

In summary, vessel anchoring and cable installation and maintenance could result in both short-term and long-term impacts to habitats used by demersal finfish, varying based on the type of habitat affected and the nature of the impact. These impacts would be limited in extent to the footprint of the disturbance. Impacts to soft-bottom habitats would be short term in duration, and habitats would recover completely without additional mitigation. Some long-term to permanent changes in complex habitat structure could occur, but the habitat functions provided by habitat-forming invertebrates would eventually recover without mitigation. On this basis, impacts to finfish from anchoring and new cable emplacement/maintenance would be **minor** adverse.

Bycatch: A range of monitoring activities have been proposed to evaluate the short-term and long-term effects of existing and planned offshore wind development on biological resources and are also likely for future wind energy projects on the OCS. Some of these monitoring activities are likely to affect finfish. For example, the South Fork Wind Fisheries Research and Monitoring Plan (SFW and Inspire Environmental 2020) included both direct sampling of finfish and the potential for bycatch and/or damage to habitat-forming invertebrates by sample collection gear. Biological monitoring uses the same types of methods and equipment employed in commercial fisheries, meaning that impacts to finfish would be similar in nature but reduced in extent in comparison to impacts from current and likely future fishing activity. Monitoring activities are commonly conducted by commercial fishers under contract who would otherwise be engaged in fishing activity. As such, research and monitoring activities related to offshore wind would not necessarily result in an increase in bycatch-related impacts on finfish, although the distribution of those impacts could change. Therefore, any bycatch-related impacts on finfish would be **negligible** to **minor** adverse and short term in duration.

Climate change: Global climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These changes have affected habitat suitability for the finfish community of the GAA and surrounding region, including several EFH species. For example, several finfish species have shifted in distribution to the northeast, farther from shore and into deeper waters, in response to an overall increase in water temperatures and an increasing frequency of marine heat waves (NOAA 2021). Warmer water could influence finfish migration and could increase the frequency or magnitude of disease (Brothers et al. 2016; Hoegh-Guldberg and Bruno 2010). Climate change is also contributing to shifts in finfish geographic ranges, individual fish health and viability, increased frequency of fatal marine heatwaves, and apparent reductions in marine productivity (NOAA 2021). These trends are expected to continue under the No Action Alternative. The intensity of impacts to finfish from climate change are uncertain but are anticipated to range from **minor** beneficial to **moderate** adverse overall, varying in significance by species.

EMF: Numerous submarine power and communications cables are present within the RWEC corridor, with most running parallel to the RWEC. These cables would presumably continue to operate and generate EMF effects under the No Action Alternative. While the type and capacity of those cables are not specified, the associated baseline EMF effects can be inferred from the available literature. Electrical telecommunications cables are likely to induce a weak EMF on the order of 1 to 6.3 µV/m within 3.3 feet (1 m) of the cable path (Gill et al. 2005). Fiber-optic communications cables with optical repeaters would not produce EMF effects. EMF effects from submarine power cables would be similar in magnitude to those described for the Proposed Action but would vary depending on specific transmission load. For example, the two power cables supplying Nantucket Island at a typical load of 46 kV and 420 amps (Balducci et al. 2019).

Under the No Action Alternative, up to 13,469 miles of offshore wind–related transmission cable installation would be added in the finfish GAA, producing EMF in the immediate vicinity of each cable during operations. BOEM anticipates that proposed offshore wind energy projects would use HVAC transmission, but HVDC designs are possible and could occur. BOEM would require these future submarine power cables to have appropriate shielding and burial depth to minimize potential EMF effects. EMF effects on finfish from these future projects would vary in extent and significance depending on overall cable length, the proportion of buried versus exposed cable segments, and Project-specific transmission design (e.g., HVAC or HVDC, transmission voltage, etc.). Because measurable EMF effects are generally limited to within tens of feet of cable corridors, these future activities would not affect existing EMF conditions unless a transmission cable were routed directly through the GAA. Accordingly, EMF effects from future activities would most likely be negligible adverse. However, Hutchison et al. (2018, 2020a) have observed behavioral responses in rays experimentally exposed to EMF from HVDC transmission. Electrosensitive fishes are adapted to detect biogenic DC EMF or EMF with AC frequencies below 10 Hz (CSA Ocean Sciences Inc and Exponent 2019). Thus, the exclusive use of 60 Hz AC in underwater transmission cables for offshore wind is not expected to induce significant behavioral responses in electrosensitive animals. In general, the widespread development of transmission infrastructure for offshore wind energy may result only in localized EMF effects of sufficient intensity to affect the behavior of individual finfish. Measurable EMF levels would diminish rapidly with distance, typically becoming indistinguishable from the baseline conditions within less than 30 feet of both buried and exposed cable segments (Exponent 2023). EMF sufficient to cause behavioral effects in fish would be highly localized, typically restricted to areas within 3 feet or less of exposed cable segments. Localized and short-term EMF effects on individual finfish would occur throughout the life of each wind energy Project but are unlikely to have measurable population-level effects on any species at the scale of the GAA. Therefore, EMF from planned and potential future activities would have a **negligible to minor** adverse effect if HVAC is used, or **moderate** adverse if HVDC is used.

Noise: Several proposed offshore wind construction projects could be developed on the Mid-Atlantic OCS between 2022 to 2030, including some projects in proximity to the RWF (see Appendix E). This would result in noise-generating activities, specifically, impact pile driving, HRG surveys, construction and O&M vessel use, and WTG operations. BOEM believes it is reasonable to conclude that impact pile driving, construction vessel, and HRG survey noise from future projects would generate short-term adverse effects on finfish within the GAA. Due to the unknowns associated with future projects, the timing, extent, and severity of these effects on habitat and aquatic community structure cannot currently be quantified.

Popper et al. (2014) compiled available research on underwater noise effects on fish and other aquatic life and established thresholds for mortality and permanent injury, recoverable injury, and TTS for different types of noise sources based on life stages or hearing group specific sensitivity (Table 3.13-4).

Table 3.13-4. Noise Exposure Thresholds for Finfish Lethal Injury, Temporary Threshold Shift, and Behavioral Effects

Sound Source	Fish Hearing Group	Lethal Injury, Peak*,†	Lethal Injury, Cumulative*,‡	Recoverable Injury, Cumulative*,‡	Temporary Threshold Shift*,‡	Behavioral§
Impact pile driving	Fish with swim bladder, involved in hearing	207	207	203	186	150
	Fish with swim bladder, not involved in hearing	207	210	203	186	150
	Fish without swim bladder	213	219	216	186	150
	Eggs and larvae	210	207	None defined	None defined	N/A
UXO detonation	All fish hearing groups	229	None defined	None defined	None defined	None defined
	Eggs and Larvae	>13 mm/s¥	None defined	None defined	None defined	N/A
HRG surveys	All fish	N/A	N/A	N/A	186	150

Notes: N/A = not applicable.

* Thresholds from Popper et al. (2014).

† Values in dB re 1 µPa.

‡ Values in decibels referenced to the sum of cumulative pressure in micropascals squared, normalized to 1 second.

¥ Particle acceleration exposure threshold (Popper et al. 2014).

§ Threshold from FHWG (2008).

Popper et al. (2014) have defined different thresholds for different fish species groups and life stages based on the current understanding of sound sensitivity. For evaluating direct effects on fish, any area exposed to construction and installation-related underwater noise sufficient to cause lethal injury, recoverable injury, TTS, and/or behavioral effects is considered to be temporarily unsuitable for the affected fish. This constitutes a minor to moderate adverse effect on fish lasting for the duration of the associated noise source.

The currently available underwater noise exposure thresholds for fish are based on the sound pressure component. Several fish species, notably those species in the hearing specialist group such as Atlantic cod, are also sensitive to the particle motion component of sound (Hawkins et al. 2021; Popper and Hawkins 2018; Roberts and Elliot 2017). Impulsive noise sources, notably impact pile driving and UXO detonation, can produce intense particle motion effects within a short distance of the sound source and can transmit particle motion effects in low frequency bands (1–40 Hz) over broader distances through vibration of the seafloor (Hawkins et al. 2021). Particle motion effects from substrate vibration caused by impact pile driving and UXO detonation could be detectable to sensitive fish species on or within a few feet of the seafloor to potentially several thousand feet of the source (Hawkins et al. 2021). Other sound sources, including HRG surveys, seafloor preparation, and cable laying activity, would also produce particle motion effects. HRG survey equipment is suspended in the water column and does not contact the seafloor; therefore, particle motion effects are likely to be limited to within tens of feet or less of the mobile sound source. In contrast, seafloor preparation and cable laying activities occur on the seafloor. Particle motion effects from these sources have not been directly studied. However, the sound and vibration energy generated by these activities are much less intense than those produced by impact pile driving. For example, cable trenching using jet and mechanical plows produces noise levels on the order of 178 to 188 dB re 1 μPa m (Bald et al. 2015; Nedwell et al. 2003). On this basis, it is reasonable to infer that particle motion effects from these activities are unlikely to exceed those generated by impact pile driving and UXO detonation.

Particle motion effects are unlikely to cause injury to fish but could affect their behavior (Hawkins et al. 2021; Roberts and Elliot 2017). Fish species that have benthic or epibenthic life stages, such as Atlantic herring (spawning adults and eggs), ocean pout (all life stages), little skate (all life stages), winter flounder (all life stages), red hake (juveniles and adults), monkfish (juveniles and adults), and winter skate (all life stages), are most likely to be exposed to particle motion and substrate vibration effects from pile driving, UXO detonation, and cable laying activities. Pelagic fish species and life stages in proximity (i.e., within feet to tens of feet) to sound sources may also be exposed to particle motion effects.

Popper and Hawkins (2018) conclude that Atlantic cod, and probably many other fish species in the hearing specialist group, are sensitive to both sound pressure and particle motion and use both aspects of sound to assess and orient themselves in the three-dimensional aquatic environment. This ability likely enables fishes to locate a particular source of sound, such as prey or potential mates, and may also assist them in identifying and locating sounds from a particular source within the general ambient noise environment. Anthropogenic sounds that interfere with the ability to detect sound pressure and particle motion could interfere with this ability (Hawkins et al. 2021). Although these potential effects are acknowledged, exposure thresholds for the particle motion component of sound have yet to be developed for finfish (Hawkins et al. 2021). Given this, potential effects to finfish from the particle motion component of sound cannot be fully assessed at this time.

The planned and future development of offshore wind energy facilities could affect the endangered Atlantic sturgeon and the threatened giant manta ray, primarily through exposure to harmful levels of underwater noise during Project construction. Adult and subadult endangered Atlantic sturgeon are expected to occur in the GAA throughout the year but appear to be present in lower numbers in the summer (Dunton et al. 2015; Ingram et al. 2019; Savoy and Pacileo 2003; Stein et al. 2004). The GAA for finfish is used by all five ESA-listed DPSs of Atlantic sturgeon, and individuals from these DPSs could be exposed to construction and O&M-related effects on demersal finfish species. The threatened giant manta ray is expected to occur in the waters south of the RI/MA WEA, within upwelling waters at the edge of the continental shelf break. Giant manta ray occurrence on the Mid-Atlantic OCS is rare (Miller and Klimovich 2017), but occurrence in proximity to some proposed future actions within the GAA cannot be completely discounted. The most significant impacts on Atlantic sturgeon and giant manta ray are expected from exposure to pile-driving noise and UXO detonation during construction. However, potentially harmful noise levels would be expected to occur close to the pile, and most mobile fish would be expected to move away from pile-driving activities, limiting the potential effects of elevated underwater noise levels. Given that construction noise impacts from future projects are likely to be similar to those described in Section 3.13.2.2.1 for construction of the Proposed Action, effects to Atlantic sturgeon and giant manta ray from individual projects would be limited to short-term minor adverse behavioral effects and disturbance. Shortnose sturgeon are unlikely to be exposed to impact pile-driving noise but could be exposed to underwater noise from UXO detonation and RWEC construction activities in or near Narragansett Bay. Shortnose sturgeon have not been reliably documented in Narragansett Bay. But, as stated previously, individuals from the nearby Connecticut River population could occur there based on observed migratory patterns between other river systems in New England (Dionne et al. 2013; Fernandes et al. 2010). For this reason, planned and reasonably foreseeable future activities are not likely to result in adverse population-level consequences on either of these species and would therefore be **minor** adverse.

Tougaard et al. (2020) summarized available monitoring data on wind farm operational noise, including both older generation geared turbine designs and quieter modern direct drive systems like those proposed for the RWF. They determined that operating turbines produce underwater noise on the order of 110 to 125 L_{RMS}, occasionally reaching as high as 128 L_{RMS}, in the 10-Hz to 8-kHz range. This is consistent with the noise levels observed at the BIWF (110 to 125 SPL) (Elliot et al. 2019) and the range of values observed at European wind farms and is therefore representative of the range of operational noise levels likely to occur from future wind energy projects. However, the 6-MW turbines used at BIWF may not be representative of noise levels produced by higher-capacity WTG designs like those considered for the Project. No comparable observational data have been collected for the larger-capacity WTGs proposed for Revolution Wind. Stober and Thomsen (2021) used monitoring data and modeling to estimate operational noise from larger (10 MW) current generation direct drive WTGs and concluded that these designs could generate higher operational noise levels than those reported in earlier research. This suggests that operational noise effects on finfish, including EFH species, could be more intense and extensive than those considered herein, but the findings have not been validated. In general, these noise levels are below established behavioral thresholds for fish (see Table 3.6-7, Section 3.6.2.3.1), comparable to environmental baseline levels in busy marine traffic areas, and unlikely to be detectable to fish outside the respective wind farm footprints. Further, whether or not auditory masking occurs and has an effect on survival and reproduction in the wild around operational offshore wind farms is not known (Mooney et al. 2020). In Europe, some species, such as Atlantic cod, have shown no response in relation to sound levels and have shown increases in abundance close to wind turbines (Bergström et al. 2013). Proposed time-of-year (TOY) restrictions for pile-driving activity for other offshore wind projects in the region would minimize adverse impacts from construction on Atlantic cod spawning. Further, proposed mitigations, such as passive acoustic monitoring (PAM) plans, would improve understanding of these potential impacts and inform future management and mitigation measures. The information currently available suggests the effects of operational underwater noise from future activities would occur for the life of the Project but are not anticipated to have population-level effects and would therefore be **minor** for some species and **negligible to minor** adverse for others. On balance, construction noise impacts from future activities that would occur for the life of the Project would likely range from **minor** to **moderate** adverse. Construction noise, such as pile driving, could result in notable and measurable adverse impacts to finfish, including to the richness or abundance of local species common to the area or to the extent and quality of the habitat. Although, finfish resources would be expected to completely recover when remedial or mitigating actions are taken (e.g., TOY restrictions).

Presence of structures: The future addition of up to 3,113 new WTG and OSS foundations on the Mid-Atlantic OCS could result in hydrodynamic and artificial reef effects that influence finfish community structure within and in proximity to project footprints and beyond. This could in turn influence the abundance and distribution of finfish species. While hydrodynamic and reef effects would largely be limited to the areas within and or close to wind farm footprints, the development of individual or contiguous wind energy facilities in nearby areas could produce cumulative effects that are beneficial for some finfish species and detrimental for others.

The widespread development of offshore renewable energy facilities would create a distributed network of artificial reefs on the Mid-Atlantic OCS. These reefs form biological hotspots that could support species range shifts and expansions and changes in biological community structure (Degraer et al. 2020; Methratta and Dardick 2019; Raoux et al. 2017). In general, species that are attracted to the structural complexity and increased biological productivity provided by the structures may benefit and increase in abundance. In contrast, species associated with soft-bottom habitats may be permanently displaced by the long-term presence of the structures. Those changes could influence fish community structure within the GAA in the future, but the likelihood, nature, and significance of these potential changes are difficult to predict and a topic of ongoing research. Artificial structures may also provide opportunities for range expansion by invasive species in conjunction with range shifts due to climate change (Degraer et al. 2020; Langhamer 2012; Schulze et al. 2020). Overall, these effects would range in significance from **minor** adverse for some species to **moderate** beneficial for others.

The Mid-Atlantic Bight cold pool is a mass of relatively cool water that forms in the spring and is maintained through the summer by stratification. The cold pool supports a diversity of fish species that are usually found farther north but thrive in the cooler waters it provides (Chen 2018; Lentz 2017). Changes in the size and seasonal duration of the cold pool over the past 5 decades are associated with shifts in the fish community composition of the Mid-Atlantic Bight (Chen 2018; Saba and Munroe 2019). The GAA and neighboring lease areas within the RI/MA and MA WEAs are located on the approximate northern boundary of the cold pool. The potential effects of extensive wind farm development on features like the cold pool is a topic of emerging interest and ongoing research (Chen et al. 2016). Changes in cold pool dynamics resulting from future activities, should they occur, could conceivably result in changes in habitat suitability and fish community structure but the extent and significance of these potential effects are largely unknown.

Human-made structures, especially tall vertical structures such as foundations, alter local water flow at a fine scale by potentially reducing wind-driven mixing of surface waters or increasing vertical mixing as water flows around the structure (Carpenter et al. 2016; Cazenave et al. 2016; Segtnan and Christakos 2015). When water flows around the structure, turbulence is introduced that influences local current speed and direction. Turbulent wakes have been observed and modeled at the kilometer scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). Although impacts on current speed and direction decrease rapidly around monopiles, there is a potential for hydrodynamic effects out to a kilometer from a monopile (Li et al. 2014). Direct observations of the influence of a monopile extended to at least 300 m, but the monopile was indistinguishable from natural variability in a subsequent year (Schultze et al. 2020). The range of observed changes in current speed and direction 300 to 1,000 m from a monopile is likely related to local conditions, wind farm scale, and sensitivity of the analysis. In strongly stratified locations, the mixing seen at monopiles is often masked by processes forcing towards stratification (Schultze et al. 2020), but the introduction of nutrients from depth into the surface mixed layer can lead to a local increase in primary production (Floeter et al. 2017).

A growing body of research has demonstrated that offshore wind farms could have observable effects on oceanographic conditions up to tens of miles downfield from wind farm sites (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022; Floeter et al. 2022; Raghukumar et al. 2022). These atmospheric and oceanographic effects can also influence stratification and mixing of surface waters, although the extent of these effects and resulting significance on biological processes are likely to vary considerably between different oceanographic environments (van Berkel et al. 2020).

Van Berkel et al. (2020) and Schultze et al. (2020) note that environments characterized by strong seasonal stratification, such as the Mid-Atlantic Bight, are likely to be less sensitive to changes and disruptions to oceanographic processes from atmospheric effects. In addition, atmospheric effects are influenced by WTG design. Golbazi et al. (2022) demonstrated that the surface effects of wind wakes from 10- to 15-MW WTGs (the size range being considered for development in the region) were less than those produced by smaller turbine designs currently employed in Europe (Akhtar et al. 2022; Christiansen et al. 2022; Daewel et al. n.d. [2023]). Broadly speaking, the atmospheric effects of wind farms appear to decrease as WTG hub height above the sea surface increases. Collectively, these findings indicate that planned and probable future wind farm development on the Mid-Atlantic OCS is not likely to produce hydrodynamic effects on the order of those associated with European wind farm development in the southern North Sea (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022).

This conclusion is supported by regional modeling. BOEM has conducted a modeling study to predict how turbulent wakes and atmospheric effects resulting from offshore wind development in the RI/MA and MA WEAs could affect hydrodynamic conditions in the northern Mid-Atlantic Bight. Johnson et al. (2021) considered a range of development scenarios, including full build-out of both WEAs with 1,063 WTG and OSS foundations at approximately 1-nm spacing. Johnson et al. (2021) determined that all scenarios would lead to small but measurable changes in current speed, wave height, and sediment transport in the northern Mid-Atlantic Bight. In addition, small changes in stratification could occur. Specifically, stratification within and downfield from the WEAs was likely to strengthen, leading to prolonged retention of cold water near the seafloor during spring and summer. These findings suggest that offshore wind development in these WEAs is unlikely to negatively disrupt cold pool dynamics.

Hydrodynamic effects would lead to changes in surface current and circulation patterns within and around the WEAs, which would in turn affect the dispersal of planktonic organisms, eggs, and larvae. Johnson et al. (2021) used an agent-based model to evaluate how these oceanographic impacts could affect planktonic dispersal and larval settlement for two fish species (summer flounder and silver hake) and the Atlantic sea scallop. In the case of scallops, they determined that offshore wind development could affect egg and larval dispersal patterns, leading to increases in larval settlement density in some areas and decreases in others. For example, silver hake larval settlement was modeled to increase in the undeveloped region east of proposed offshore wind leases under a scenario that considered full development of all planned offshore wind facilities due to induced changes to current speeds. In contrast, summer flounder would experience a slight reduction in the density of settled larvae in central Nantucket Sound and an increase in larval density in inshore coastal habitats on Montauk and Nantucket Islands, Rhode Island, and Connecticut under the same scenario (Johnson et al. 2021). However, these small and localized effects are unlikely to be biologically significant at population levels as the larvae of these species originate from both local and distant spawning areas and are dispersed throughout the region (Johnson et al. 2021).

Prior to the Johnson et al. (2021) analysis, Chen et al. (2016) used a hydrodynamic model to assess how the installation of large numbers of wind turbines on the Mid-Atlantic OCS would impact oceanographic processes during storm events. They determined that structure presence would not have a significant influence on southward larval transport from Georges Bank and Nantucket Shoals into the Mid-Atlantic Bight, but wind farm development could lead to an increase in cross-shelf larval dispersion. The combined findings of the Johnson et al. (2021) and Chen et al. (2016) modeling studies indicate that broad changes in regional circulation patterns are unlikely to occur as a result of regional offshore wind development. These patterns are broadly consistent over time but vary from year to year, and organisms that depend on circulation-driven larval dispersal are adapted to that variability (Chen et al. 2021; McCay et al. 2011; Munroe et al. 2018; Roarty et al. 2020; Zhang et al. 2015). In this context, localized shifts in larval transport and settlement density on the scale of miles to tens of miles are unlikely to negatively affect larval survival at regional scales. Even where they occur, localized changes to larval recruitment may not necessarily translate to negative effects on adult biomass. For example, Atlantic sea scallops are prone to overcrowding and reduced growth rates in areas where larval recruitment exceeds carrying capacity (Bethoney and Stokesbury 2019). In such cases, changes in dispersal that reduce overcrowding could lead to positive effects on larval growth and survival to adulthood.

While hydrodynamic impacts on finfish are likely to vary between species, the modeled findings for summer flounder and silver hake are likely representative of the magnitude of potential effects on most fish species that rely on current-driven dispersal of planktonic larvae. Localized changes in larval settlement patterns in the absence of population-level effects would constitute a **minor** adverse impact on this resource. This impact would be effectively permanent.

Sediment deposition and burial: Cable placement and other related construction activities would disturb the seafloor, creating plumes of fine sediment that would disperse and resettle in the vicinity. The resulting effects on finfish would be similar in nature to those observed during construction of the BIWF (Elliot et al. 2017) but would vary in extent and severity depending on the type and extent of disturbance and the nature of the substrates. For example, fish exposed to low levels of suspended sediment on the order of 100 to 500 mg/L may simply suspend feeding and avoid the affected area. Fish exposed to higher concentrations of suspended sediments (e.g., greater than 1,000 mg/L) may experience short-term stress and physiological injury. The benthic eggs and larvae of some finfish species are sensitive to burial and could be injured or killed by sediment deposition (Kjelland et al. 2015; Michel et al. 2013; Wilber and Clarke 2001). While sensitivity varies widely, the eggs and larvae of some species can be killed by as little as 0.4 inch (10 mm) of sediment deposition. The eggs of certain species, like winter flounder, are particularly sensitive and can be killed by burial depths less than 0.1 inch (3 mm) (Michel et al. 2013). Effects of this magnitude are likely to occur during the construction of any planned or potential future offshore wind energy project. The highest suspended sediment levels would occur closest to the disturbance and would dissipate with distance, generally returning to baseline conditions within a few hours (RPS 2022). Observations from the construction of the BIWF showed that suspended sediments returned to baseline levels faster than predicted by preconstruction modeling (HDR 2020). In theory, bed-disturbing activities occurring nearby (i.e., within a few hundred feet) could elevate suspended sediment levels within the GAA, resulting in short-term minor adverse effects on finfish. However, most fish species are mobile enough to avoid harmful suspended sediments.

While suspended sediment and burial effects are an unavoidable consequence of offshore wind energy construction, O&M, and decommissioning, these effects would be limited in extent and short term in duration, effectively ending once the sediments have resettled. Individual finfish could be adversely affected, but the number of individuals impacted and the duration of effects would be unlikely to adversely affect any finfish species at the population level at the scale of the GAA and would therefore be **minor** adverse.

3.13.2.2.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on finfish associated with the Project would not occur. However, ongoing and future activities would have continuing short-term, long-term, and permanent impacts on finfish primarily through pile-driving noise, new cable emplacement, and the presence of structures related to other wind projects within the GAA. Climate change impacts would similarly continue to impact finfish populations regionally.

BOEM anticipates that the impacts of ongoing activities, including climate change, port development and expansion, navigation dredging, and continued recreational and commercial fishing activity, would be **moderate** adverse for finfish species in the GAA. Fish stock management is an important component of maintaining healthy fish stocks. In the absence of climate change and other impact-generating activities, fishing activity would contribute to ongoing **minor** adverse impacts to finfish. In addition to ongoing wind farm activities, reasonably foreseeable activities other than offshore wind could also contribute to impacts on finfish. Based on the same reasonably foreseeable activities noted above, BOEM anticipates that the impacts of reasonably foreseeable new activities (e.g., increased vessel traffic) other than offshore wind would be **minor** adverse. BOEM expects the combination of ongoing activities and reasonably foreseeable activities other than offshore wind to result in **moderate** adverse impacts on finfish.

The combined significance criteria are used to characterize the combined effects of all IPFs likely to occur in the GAA under the No Action Alternative. BOEM anticipates that the impacts associated with future offshore wind activities in the GAA combined with ongoing activities, reasonably foreseeable environmental trends (i.e., climate change), and reasonably foreseeable activities other than offshore wind would result in **moderate** adverse impacts and could include **moderate** beneficial impacts to finfish.

Future offshore wind activities are expected to generate impacts under several IPFs, the most prominent being the presence of structures—namely, foundations and scour/cable protection.

The No Action Alternative would forgo the fisheries monitoring that Revolution 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; and inform planning of other offshore developments. However, other ongoing and future surveys could still provide similar data to support similar goals.

3.13.2.3 Alternative A: Impacts of the No Action Alternative on Essential Fish Habitat

3.13.2.3.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for essential fish habitat (see Section 3.13.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the geographic analysis area. These IPFs are described and analyzed in Appendix E1.

3.13.2.3.2 Cumulative Impacts

This section discloses potential essential fish habitat impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

Offshore Activities and Facilities

This section discloses potential EFH impacts associated with future offshore wind development. Analysis of impacts associated with ongoing activities and future non–offshore wind activities is provided in Appendix E1. The duration of impacts disclosed for this resource deviate slightly from general guidelines provided in Section 3.3.

<u>Accidental releases and discharges:</u> As stated previously for finfish, offshore wind energy development could result in the accidental release of water quality contaminants or trash/debris, which could theoretically lead to an increase in debris and pollution in the GAA (see Section 3.21 for a characterization of existing water quality conditions). In general, the types of accidental hazardous materials releases that would impact finfish would also impact EFH. Project proponents would be required to comply with state and federal regulations to avoid the discharge of solid debris and unintentional introduction of nonnative species. Compliance with BOEM and USCG requirements would effectively minimize releases of trash and debris. Similar to finfish, effects on EFH would be expected to be **negligible** adverse.

<u>Anchoring and new cable emplacement/maintenance:</u> Offshore wind energy facility construction would involve direct disturbance of the seafloor leading to direct impacts on EFH. In general, these effects would be localized to the disturbance footprint and vicinity. The specific type and extent of habitat conversion and resulting effects would vary depending on the project design, species present, and site-specific conditions. Future activities would also disturb up to 101,381 acres of seafloor during cable installation, although the impacts from this disturbance on EFH would be **minor** adverse. See Section 3.13.1.1.1 for additional details.

Climate change: As stated previously for finfish, climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. These trends are expected to continue under the No Action Alternative. The intensity of impacts resulting from climate change are uncertain but are anticipated to be **minor** to **moderate** adverse.

EMF: At least seven submarine power and communications cables are in the vicinity of the RWEC corridor, with most running parallel the RWEC. These cables would presumably continue to operate and generate EMF effects under the No Action Alternative. While the type and capacity of those cables are not specified, the associated baseline EMF effects can be inferred from the available literature. Electrical telecommunications cables are likely to induce a weak EMF on the order of 1 to 6.3 µV/m within 3.3 feet (1 m) of the cable path (Gill et al. 2005). Fiber-optic communications cables with optical repeaters would not produce EMF effects.

Under the No Action Alternative, up to 13,469 miles of cable installation would be added in the GAA, producing EMF in the immediate vicinity of each cable during operations. BOEM anticipates that proposed offshore wind energy projects would use HVAC transmission, but HVDC designs are possible and could occur. BOEM would require these future submarine power cables to have appropriate shielding and burial depth to minimize potential EMF effects from cable operations. EMF effects on EFH from these future projects would vary in extent and significance depending on overall cable length, the proportion of buried versus exposed cable segments, and project-specific transmission design (e.g., HVAC or HVDC, transmission voltage, etc.). Because measurable EMF effects are generally limited to within tens of feet of cable corridors, these future activities would not affect existing EMF conditions unless a transmission cable were routed directly through the GAA. Accordingly, EMF effects from future activities would most likely be **negligible** adverse. However, Hutchison et al. (2018; 2020a) have observed behavioral responses in electrosensitive fish that were exposed to EMF from a HVDC cable in a controlled environment. These findings suggest more extensive behavioral impacts resulting in higher level (e.g., **minor** or **moderate**) adverse effects could result should future projects use HVDC transmission.

Noise: As mentioned above for finfish, several proposed offshore wind projects could be developed on the Mid-Atlantic OCS between 2022 to 2030, including some projects in proximity to the RWF (see Appendix E), resulting in noise-generating activities. BOEM believes it is reasonable to conclude that future projects could result in **negligible to moderate** adverse effects to EFH.

Presence of structures: As discussed under finfish, BOEM conducted a modeling study to predict how planned offshore wind development in the RI/MA and MA WEAs could affect hydrodynamic conditions northern Mid-Atlantic Bight. BOEM determined that small but measurable changes in current speed, wave height, and sediment transport in the northern Mid-Atlantic Bight would occur. In addition, small changes in stratification could occur, leading to prolonged retention of cold water near the seafloor within the WEAs during spring and summer. However, these localized and small effects are unlikely to be biologically significant at population levels (Johnson et al. 2021).

While hydrodynamic impacts on EFH are likely to vary between species, the modeled findings for summer flounder and silver hake are likely representative of the magnitude of potential effects on species having planktonic larvae. Localized changes in larval settlement patterns in the absence of population-level effects would constitute a **minor** adverse impact on this resource. This impact would be effectively permanent.

The future addition of up to 3,088 new WTG and OSS foundations on the Mid-Atlantic OCS could result in hydrodynamic and artificial reef effects that influence finfish community structure within and in proximity to project footprints. This could in turn influence the abundance and distribution of EFH species. While hydrodynamic and reef effects would largely be limited to the areas within and/or close to wind farm footprints, the development of individual or contiguous wind energy facilities in nearby areas could produce cumulative effects that would be permanent and **moderate** beneficial for some species from habitat conversion and have **minor** adverse effects due to permanent habitat loss. New structures would attract structure-oriented fishes as long as the structures remain. Abundance of certain fishes could increase with short-term to permanent **moderate** adverse impacts.

Hydrodynamic disturbance resulting from the broadscale development of large offshore wind farms is a topic of emerging concern because of potential effects on the Mid-Atlantic Bight cold pool. The cold pool is a mass of relatively cool water that forms in the spring and is maintained through the summer by stratification. The cold pool supports a diversity of fish species that are usually found farther north but thrive in the cooler waters it provides (Chen 2018; Lentz 2017). Changes in the size and seasonal duration of the cold pool over the past 5 decades are associated with shifts in the fish community composition of the Mid-Atlantic Bight (Chen 2018; Saba and Munroe 2019). The GAA and neighboring lease areas within the RI/MA and MA WEAs are located on the approximate northern boundary of the cold pool. The potential effects of extensive wind farm development on features like the cold pool is a topic of emerging interest and ongoing research (Chen et al. 2016). Changes in cold pool dynamics resulting from future activities, should they occur, could conceivably result in changes in habitat suitability and fish community structure but the extent and significance of these potential effects are unknown.

<u>Sediment deposition and burial:</u> As discussed under finfish, cable placement and other related construction activities would create plumes of fine sediment that would disperse and resettle. These effects would be short term in duration, effectively ending once the sediments have resettled. Similarly, suspended sediment concentrations close to the disturbance could exceed levels associated with behavioral and physiological effects on fish but would dissipate with distance, generally returning to baseline conditions within a few hours. In theory, bed-disturbing activities occurring nearby (i.e., within a few hundred feet) could elevate suspended sediment levels within the GAA, resulting in short-term **minor** adverse effects.

3.13.2.3.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on EFH resulting from the Project would not occur. However, ongoing and future activities would have continuing short-term to long-term impacts on EFH species and habitats, primarily as a result of construction-related noise impacts, operational noise, seafloor disturbance and habitat modifications, hydrodynamic and reef effects resulting from the presence of offshore wind energy structures, and the interactions between these impacts and the ongoing effects of climate change.

The combined significance criteria are used to characterize the combined effects of all IPFs likely to occur in the GAA under the No Action Alternative. BOEM anticipates that the impacts of ongoing activities—especially fishing, navigation dredging, coastal development, and climate change—would be **moderate** adverse for EFH species. Fish stock management is an important component of maintaining healthy fish stocks. In addition to ongoing activities, reasonably foreseeable activities other than offshore wind could also contribute to impacts on EFH. BOEM anticipates that the impacts of reasonably foreseeable activities other than offshore wind and climate change on EFH would be **minor** adverse. BOEM expects the combination of ongoing activities, climate change, and reasonably foreseeable activities other than offshore wind to result in **moderate** adverse impacts on EFH, with moderate adverse impacts resulting primarily from climate change.

BOEM anticipates that future offshore wind activities in the GAA combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in **moderate** adverse and could include **moderate** beneficial impacts to EFH. 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 No Action Alternative would forgo the fisheries monitoring that Revolution 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 EFH; and inform planning of other offshore developments. However, other ongoing and future surveys could still provide similar data to support similar goals.

3.13.2.4 Alternative B: Impacts of the Proposed Action on Finfish

3.13.2.4.1 Construction and Installation

Offshore Activities and Facilities

<u>Accidental releases and discharges</u>: The impact to finfish from trash, debris, and spills from the Project would be the same as described under the No Action Alternative; **negligible** adverse.

In the unlikely event a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, **minor** to **moderate** adverse effects on finfish, including listed finfish, could result. These effects could be short term to long term in duration depending on the type and volume of material released, the duration of exposure, and the animals and life stages exposed; fish eggs and larvae are less mobile and are considered more susceptible to spilled materials in surface waters (see Section 3.21.1.2).

<u>Anchoring and new cable emplacement/maintenance:</u> Finfish within the construction footprint would be exposed to risk of displacement, crushing, and burial during seafloor preparation of cable corridors, cable installation, placement of cable protection, and vessel anchoring. These activities would also impact benthic habitats used by certain finfish species, with the effects ranging in duration from short term to long term. The acres of construction-related seafloor disturbance are summarized by benthic habitat type in Section 3.6.2.4.1 and Table 3.6-4. As shown, seafloor disturbance from jack-up vessels and general vessel anchoring could impact up to 3,247 acres. Seafloor disturbance from various overlapping cable installation activities, including boulder relocation, jet plow trenching for cable installation, and placement of cable protection could impact up to 2,043 acres distributed throughout the RWF and RWEC maximum work areas.

Finfish within these construction footprints would be directly exposed to disturbance. Juvenile and adult fish are mobile and would likely avoid being harmed or killed by construction equipment and materials placement. In contrast, certain fish species, such as cod, ocean pout, Atlantic pollock, and winter flounder, have benthic eggs and/or larvae that would be vulnerable to these effects. The extent of exposure would vary by species and habitat association. For example, ocean pout eggs are typically found in hard-bottom substrates, meaning that this species more likely to be exposed to boulder relocation and placement of scour and cable protection in large-grained complex and complex habitats. Winter flounder lay their eggs in soft-bottom benthic habitat, which translates to greater exposure to jet plow, sea-to-shore transition construction, and vessel anchoring in this habitat type. Approximately 58% of the estimated construction disturbance footprint is composed of soft-bottom habitat, 15% is large-grained complex habitat, and 27% is complex habitat ranging from boulders and cobbles to complex mixtures of mobile sand, gravel, cobble, and boulders.

The estimated anchoring impacts are presented in Section 3.6.2.4.1 and Table 3.6-4 based on the best currently available information, comprising anchoring information presented in the COP and supplemental information about jack-up vessel anchoring and pull-ahead anchoring provided by Revolution Wind. The general vessel anchoring estimate of 3,167 acres comprises the area covered by 102,656-foot (200-m) radius circles, one around each proposed WTG and OSS foundation, where construction-related anchoring impacts may occur. Actual anchoring requirements and the average extent of impacts per foundation would likely be appreciably smaller. Jack-up vessel and pull-ahead anchoring acreage estimates are precise and based on currently understood anchoring requirements and equipment. Jack-up vessel anchoring during WTG and OSS foundation installation would impact approximately 21.1 acres of seafloor habitat. Some portion of these impacts would occur in areas previously impacted by seafloor preparation for foundation installation and subsequently impacted by placement of scour protection. Pull-ahead anchoring for cable installation would impact an estimated 16.1 acres, based on the anticipated number of anchoring events, anchor type, and substrate conditions in the RWEC corridor. Combined impacts from general vessel anchoring, jack-up vessel anchoring, and pull-ahead anchoring would impact up to, but likely less than, an estimated total 3,204 acres of seafloor.

Benthic habitat in the areas wherein anchoring impacts could occur is composed of approximately 19.1% large-grained complex, 30.0% complex, and 50.9% soft-bottom habitats. However, the total acreage and distribution of anchoring impacts cannot be predicted with certainty because anchoring requirements and vessel positioning are affected by construction needs and real-time wind and current conditions. The vessel anchoring plan developed by the applicant (see EPM Ben-6 in Table F-1, Appendix F) would be used to identify and avoid impacts to large-grained complex and complex benthic habitats to the greatest extent practicable. Impacts on bedforms in soft-bottom benthic habitat are expected to recover within 18 to 30 months following initial disturbance as a result of natural sediment transport processes (Daylander et al. 2012) and recolonization by habitat-forming organisms from adjacent habitats. This estimate is based on observed recovery rates from fishing-related disturbance (Grabowski et al. 2014), on cable installation impacts at the nearby BIWF (HDR 2020), and on similar seafloor disturbance impacts observed in other regions (de Marignac et al. 2008). In contrast, anchoring in complex and large-grained complex habitats could result in long-term to permanent impacts on habitat structure by redistributing coarse substrates (i.e., creation of anchor furrows) and by damaging habitat-forming organisms on those substrates.

Cable installation impact acreage values presented in Section 3.6.2.4.1 and Table 3.6-4 represent the best available estimate of the total impact footprint for the Proposed Action design, based on proposed seafloor preparation and cable installation technologies and methods. These impacts could occur anywhere within the 131-foot-wide (40-m-wide) cable installation impact corridors, which cover an estimated 1,325, 2,471, and 148 acres for the RWEC, IAC, and OSS-link, respectively. The precise location of specific seafloor preparation impacts is not currently known; therefore, the distribution of impacts by habitat type for each cable is based on the composition of its respective impact corridor. The RWF and RWEC would be sited to avoid and minimize impacts on large-grained complex and complex benthic habitats to the greatest extent practicable (see EPM Ben-1 in Table F-1, Appendix F). This would shift some of the projected impacts on complex habitats to soft-bottom habitat. Therefore, the actual distribution of impacts by habitat type will likely vary from the estimates presented in Table 3.6-4.

Seafloor preparation and cable installation activities would impact approximately 158 and 743 acres of large-grained complex and complex habitat, respectively, and 2,375 acres of soft-bottom habitat within the RWF and RWEC construction footprints. Finfish within the construction footprint would be exposed to risk of displacement, crushing, and burial during seafloor preparation of cable corridors, cable installation, placement of cable protection, and vessel anchoring. Impacts to large-grained complex and complex benthic habitat from vessel anchoring, cable installation and cable protection, and seafloor preparation could impact managed finfish that use these habitats (e.g., monkfish) and may indirectly disturb Atlantic cod spawning. Atlantic cod spawning could be disturbed if anchoring and cable emplacement activities (e.g., grapnel runs and jet plowing) are occurring in proximity. Figure 3.13-4 shows the locations of cod observation data in relation to the Proposed Action (observations primarily observed in Zone RWC 1). EMPs committed to by Revolution Wind (see Table F-1, Appendix F), including measures designed to reduce impacts to complex habitats (e.g., using a boulder grab and a work-class remotely operated vehicle boulder skid for most boulder relocations, siting export cables and WTGs to avoid hard-bottom habitats, and developing and implementing construction and O&M anchoring plans), would minimize impacts and modifications to complex habitats that support managed finfish and important biological functions like spawning.

Disturbance impacts to soft-bottom benthic habitats and associated fish species would be short term, and these habitats and species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could be long term to permanent. Long-term impacts to habitat-forming organisms in complex habitats would require several years to recover full habitat function. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat. Permanent habitat impacts would result where seafloor preparation and placement of scour protection result in conversion to a new habitat type. Although habitat structure may be altered, habitat composition in the affected areas would recover to functional condition over the life of the Project.

Recent research conducted by the NEFSC and NEFMC (BOEM 2023e) determined that HAPC features for the gadidae cod family species on Georges Bank recovered relatively quickly from damage by intensive scallop dredging activity. Near-complete recovery of benthic epifauna, including habitat-forming organisms on boulders and cobbles, was achieved within 6 years of the disturbance. Given their proximity to the Lease Area, these findings provide a useful basis for estimating the likely duration of effects of benthic habitat disturbance from anchoring disturbance and other construction-related activities.

Manta rays are pelagically oriented and planktivorous; therefore, seafloor anchoring and new cable emplacement/maintenance are unlikely to have a measurable effect on this species. In contrast, seafloor disturbance and habitat modification associated with anchoring and cable emplacement/maintenance would kill or displace sturgeon prey organisms such as worms, clams, amphipods, and other benthic infauna.

Finfish present along the cable routes may be subject to lethal crushing, burial, or entrainment effects. Adult fish would likely exhibit avoidance responses and exit the active construction and installation area, but there is potential for lethal effects. Placement of cable protection and installation of the cofferdam could crush or bury adult fish unable to avoid the area. Studies of mortality rates from dredging provide a useful basis for evaluating potential impacts from cable installation. Adult fish are typically able to avoid dredging disturbance, meaning entrainment rates are generally low (Wenger et al. 2017). Once fish are entrained, mortality rates can be high, exceeding 30% (Armstrong et al. 1982). However, the jet and mechanical plows used for cable installation are not directly comparable to dredging equipment. Dredges ingest substantial volumes of water and sediment at the seafloor. In contrast, mechanical plows physically dig sediments out of the seafloor. Jet plows draw water from near the sea surface through screened intakes and inject it into the seafloor to loosen sediments, making it easier to displace them from the cable trench. Given this, fish larvae, eggs, and small immobile juveniles that are unable to avoid seafloor preparation and cable installation equipment are most likely to be exposed to crushing, burial, and entrainment effects.

Anchoring and cable emplacement activities during construction would therefore likely result in direct impacts on larval, juvenile, and adult Atlantic cod associated with these habitats, as described above. Construction would also result in long-term to permanent impacts on the composition and structure of benthic habitats used by this species. The nature, duration, and severity of these impacts, including impacts to habitat-forming organisms, are discussed in Sections 3.6.2.2.1 and 3.6.2.3.1. Although impacts to complex habitats would be long-term to permanent in duration, it is not clear that habitat suitability for species like cod would be substantially diminished over the same duration. For example, Wilber et al. (2022a) observed an increase in Atlantic cod abundance at the BIWF compared to reference locations. Reubens et al. (2013) observed a similar increase in Atlantic cod abundance and documented the presence of settled larvae and juveniles exhibiting robust growth rates within a large European wind farm on the Baltic Sea. In both cases the observations occurred within a few years after construction was completed.

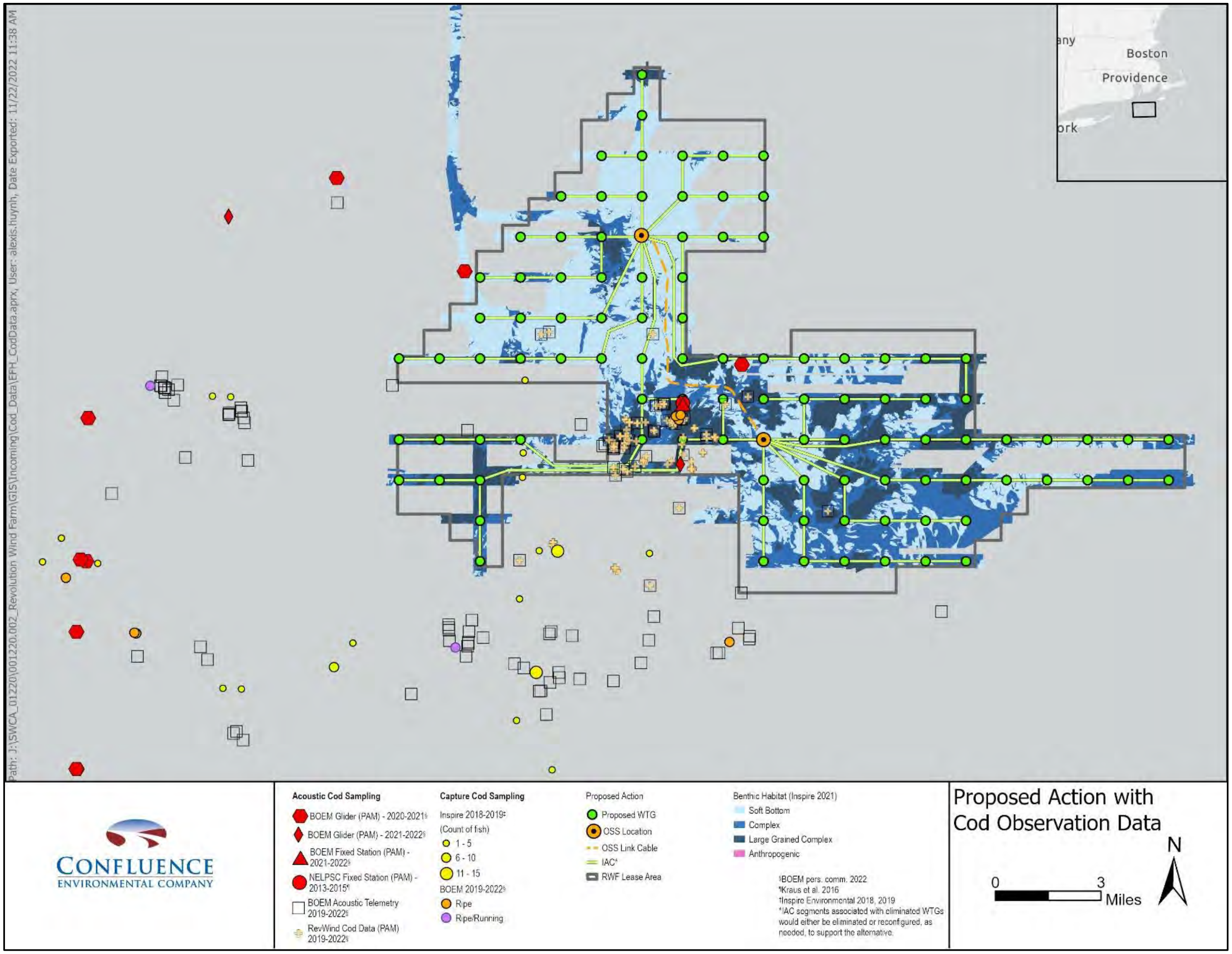

Figure 3.13-4. Proposed Action with cod observation data.

Jet plow operation during cable installation would entrain and kill pelagic fish eggs and larvae that are near the equipment intakes during operation. Both the jet and mechanical plow could entrain benthic eggs and larvae present within the seafloor disturbance footprint. While potential entrainment impacts have not been quantified for the Proposed Action, the findings of a recent analysis conducted for the adjacent SFWF provide a useful example of the magnitude of potential effects. Inspire Environmental (2019b) estimated that over a billion fish eggs could be exposed to entrainment impacts from installation of the SFEC and SFWF IAC, with exposure varying by species. For example, entrainment would kill an estimated 23,000 Atlantic cod larvae, a negligible number of haddock and Atlantic pollock larvae, and up to 2.8 million Atlantic mackerel larvae. Given the similarity in location and greater scale of cable installation activities, the Proposed Action would likely produce similar or larger entrainment effects. However, these impacts must be placed into context with natural mortality to understand their significance. The total volume of water entrained during SFWF and SFEC construction (approximately 20 million cubic meters) represented a miniscule fraction of the billions of cubic meters of near-surface habitat on the Mid-Atlantic OCS. A typical female cod lays over 1 million eggs (Alonso-Fernández et al. 2009), meaning that a spawning aggregation could produce hundreds of millions of eggs and larvae. The natural mortality rate is estimated to be 10% to 20% per day for cod eggs and 6% per day for larvae (Mountain et al. 2008). Mackerel are abundant, and each female can produce between 300,000 and 2 million planktonic eggs (Morse 1980). In this context, entrainment losses of tens of thousands of cod larvae or even several million mackerel eggs and larvae would be insignificant relative to the billions spawned in the region each year. While the Proposed Action is larger than the SFWF, and cable laying requirements are more extensive, impacts on finfish from jet plowing would be similar in scale and biologically insignificant relative to existing levels of abundance and the background mortality rate of fish eggs and larvae. On balance, entrainment of eggs and larvae would constitute a short-term adverse impact on finfish that would not result in measurable population-level impacts. Therefore, these impacts would be **minor to moderate** adverse.

Noise: Construction-related sources of noise, particle motion, and vibration that could affect finfish and/or prey resources are impact and vibratory pile driving, preconstruction HRG surveys, vessel and cable installation equipment, and UXO detonation. Popper et al. (2014) compiled available research on underwater noise effects on fish and other aquatic life and established noise exposure thresholds for mortality, injury, and TTS in different species and life stages of fish based on sensitivity to sound. The FHWG (2008) recommended a generalized threshold for behavioral effects on fish from noise exposure. These thresholds represent the current state of the science regarding potential noise effects on fish and are presented in Table 3.13-4.[41] The low-frequency noise produced by construction and installation–related vessel engine noise could also cause auditory masking effects as those described below for WTG operations. Vessel noise is a common source of low-frequency sound in the marine environment that may result in auditory masking of biologically important sounds or elicit behavioral responses. Behavioral

[41] The noise thresholds in Table 3.13-3 represent the best available science regarding finfish sensitivity to injury and behavioral-level effects from underwater noise exposure. No exposure thresholds have been defined for auditory masking effects in fish, but for the purpose of this Draft EIS, these effects are considered likely to occur at exposure levels between the behavioral threshold and the TTS threshold for each hearing group. NMFS applies different threshold criteria developed by the FHWG (2008) to evaluate underwater noise effects on ESA-listed species. The BOEM BA for the Proposed Action uses these more conservative thresholds to evaluate potential underwater noise effects on Atlantic sturgeon, manta rays, and their prey and forage species (BOEM 2023a, 2023b).

responses in fishes differ depending on species and life stage, with younger, less-mobile age classes being the most vulnerable to vessel noise impacts (Gedamke et al. 2016; Popper and Hastings 2009).

UXOs present in the maximum work area would have to be detonated if they cannot be safely relocated prior to construction. Kusel et al. (2023) and Hannay and Zykov (2022) modeled construction noise likely to result from impact pile driving and UXO detonation and calculated the distances required to attenuate noise below applicable injury and behavioral criteria for each noise source by hearing group and type of effect (see Table 3.13-4). As of February 2023, 16 UXOs have been identified in the RWEC corridor. Revolution Wind has determined that all 16 devices can be safely avoided by shifting the cable route within the approved installation corridor without the need for detonation (Orsted 2023). However, it is possible that additional devices could be discovered in preconstruction surveys or during construction that cannot be avoided or safely relocated. BOEM has concluded that the need for UXO detonation cannot be entirely ruled out; therefore, the potential effects of this activity on finfish are considered herein.

The currently available underwater noise exposure thresholds for fish are based on the sound pressure component. Several fish species, notably those species in the hearing specialist group such as Atlantic cod, are also sensitive to the particle motion component of sound (Hawkins et al. 2021; Popper and Hawkins 2018; Roberts and Elliot 2017). Impulsive noise sources, notably impact pile driving and UXO detonation, can produce intense particle motion effects within a short distance of the source and can transmit particle motion effects in low-frequency bands (1–40 Hz) over broader distances through vibration of the seafloor (Hawkins et al. 2021). Particle motion effects from substrate vibration caused by impact pile driving and UXO detonation could be detectable to sensitive fish species on or within a few feet of the seafloor to potentially several thousand feet of the source (Hawkins et al. 2021). Other sound sources, including HRG surveys, seafloor preparation, and cable laying activity, would also produce particle motion effects. HRG survey equipment is suspended in the water column and does not contact the seafloor; therefore, particle motion effects are likely to be limited to within tens of feet or less of the mobile sound source. In contrast, seafloor preparation and cable laying activities occur on the seafloor. Particle motion effects from these sources have not been directly studied. However, the sound and vibration energy generated by these activities are much less intense than those produced by impact pile driving. For example, cable trenching using jet and mechanical plows produces noise levels on the order of 178 to 188 dB re 1 μPa m, comparable to the noise levels generated by associated construction vessels (Bald et al. 2015; Nedwell et al. 2003). On this basis, it is reasonable to infer that particle motion effects from these activities are unlikely to exceed those generated by impact pile driving and UXO detonation.

Table 3.13-4 organizes fish into groups based on the presence of a swim bladder and the involvement of this organ in hearing. Noise impacts on fish vary depending on the ability of the fish to detect sound pressure. Popper et al. (2014) reviewed the available research and developed a set of recommended injury thresholds for different groups of fishes depending on their specific biological sensitivity to sound. Fish with a swim bladder or other gas chamber involved in hearing (e.g., Atlantic herring and fish in the cod family) are considered hearing specialists and are the most sensitive to underwater noise impacts. Fish that have a swim bladder that is not directly involved in hearing, or hearing generalists, are intermediate in sensitivity to noise impacts. Fish species that lack swim bladders and similar gas-filled organs (e.g., sharks, rays, and flatfish) are the least susceptible to underwater noise impacts. This group includes the Elasmobranchii, a subclass of fishes comprising sharks, skates, rays, and their relatives. Fishes in this subclass lack swim bladders or any other kind of hearing specialization and can only detect the particle motion component of sound (Casper 2006). Particle motion effects dissipate rapidly and are highly localized around the noise source, with detectable effects on finfish typically limited to within 3 to 6 feet of the source (Edmonds et al. 2016; Payne et al. 2007). Eggs and larvae lack gas-filled organs and are less susceptible to injury but are unable to avoid noise impacts because they are less mobile than adults.

As shown in Table 3.13-4, impact pile driving used to install the RWF monopile foundations is one of the most intense sources of noise resulting from the Project and would produce the most significant and extensive noise effects on fish due to the number of WTG and OSS foundations to be installed. As shown in Table 3.13-5, potentially lethal noise effects on adult fish occur from 604 to 5,883 feet from each WTG monopile and 617 to 5,194 feet from each OSS monopile. Potentially lethal effects on fish eggs and larvae could occur from 2,470 to 3,683 feet and 2,756–3,458 feet from each WTG and OSS monopile, respectively. Pile driving would produce noise above the 150 dB re 1 µPa behavioral effects threshold from 14,403 to 34,987 feet from each source, respectively. The range of threshold distances for injury from UXO detonation are for devices ranging in size from 5- to 1,000-pound devices, the latter being the largest explosive analyzed by Hannay and Zykov (2022). Detonation of 1,000-pound UXOs could injure or kill adult fish and fish eggs and larvae up to 951 and 1,384 feet from the source, respectively. Revolution Wind anticipates that up to 13 UXOs ranging from 5 to 1,000 pounds in size may need to be detonated in place (LGL 2022). The actual number and location of UXOs is not currently known, but the largest devices are most likely to be found within the central portion of the RWF and in state waters on the RWEC corridor at the mouth and outside of Narragansett Bay (Ordtek 2021).

Table 3.13-5. Distances to Underwater Noise Injury and Behavioral Thresholds by Fish Hearing Group and Exposure Type for Wind Turbine Generator and Offshore Substation Foundation Installation, Unexploded Ordnance Detonation, High-Resolution Geophysical Surveys, and Vessel Operation

Activity*	Number of Sites	Total Days	Noise Exposure Type	Hearing Group	Exposure Threshold†	Range of Threshold Distances (feet)‡
12-m WTG monopile foundation installation	100	33	Peak injury	Fish–Swim bladder involved in hearing	207	69–371
				Fish–Swim bladder not involved in hearing	207	69–371
				Fish–No swim bladder	213	13–59
				Eggs and larvae	207	69–371
			Cumulative Injury	Fish–Swim bladder involved in hearing	207	3,848–5,883
				Fish–Swim bladder not involved in hearing	210	2,470–3,638
				Fish–No swim bladder	219	604–856
				Eggs and larvae	210	2,470–3,638
			TTS	All fish	186	23,094–43,842
			Behavioral effects	All fish	150	14,403–34,987
15-m OSS monopile foundation installation	2	2	Peak injury	Fish–Swim bladder involved in hearing	207	125–299
				Fish–Swim bladder not involved in hearing	207	125–299
				Fish–No swim bladder	213	33-62
				Eggs and larvae	207	125–299

Activity*	Number of Sites	Total Days	Noise Exposure Type	Hearing Group	Exposure Threshold†	Range of Threshold Distances (feet)‡
			Cumulative injury	Fish–Swim bladder involved in hearing	207	3,885–5,194
				Fish–Swim bladder not involved in hearing	210	2,756–3,458
				Fish–No swim bladder	219	617–797
				Eggs and larvae	210	2,756–3,458
			TTS	All fish	186	20,623–38,625
			Behavioral effects	All fish	150	15,157–35,722
Temporary cofferdam installation	1	14	Behavioral effects	All fish	150	2,543
UXO detonation	13	13	Injury or mortality	All fish	229	161–951
				Eggs and larvae	>13	148–1,384
HRG surveys	10,755	248	TTS	All fish	186	16
			Behavioral effects	All fish	150	2,572
Construction vessel operation	N/A	~730	Behavioral effects	All fish	150	442

* Installation scenario for a 12-m monopile is 6,500 strikes/pile at the installation rate of three piles/day. Installation scenario for a 15-m monopile is 8,000 strikes/pile at the installation rate of one pile/day. All piles installed with a 4,000-kJ hammer with an attenuation system achieving 10 dB sound source reduction. UXO detonation results assume a worst-case scenario requiring detonation of a 1,000-pound explosive device using a attenuation achieving 10 dB of sound source reduction. Total HRG survey impact area based on an estimated 10,775 linear miles of survey effort, or approximately 48 miles per day over 248 days at an average survey vessel speed of 2.2 knots.

† Peak injury thresholds are SPL in dB re 1 µPa; cumulative injury thresholds are SEL in decibels referenced to the sum of cumulative pressure in micropascals squared, normalized to 1 second for 12 hours of exposure; behavioral injury threshold is SPL in dB re 1 µPa. The UXO detonation threshold for eggs and larvae is particle acceleration exceeding 13 millimeters per second.

‡ Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur. WTG and OSS values are the range of threshold distances for monopile installation modeled by Kusel et al. (2023) across modeled sites and seasonal conditions. Revolution Wind anticipates up to 13 UXOs requiring detonation in place could be encountered in the maximum work area, with devices ranging in size from 5 to 1,000 pounds (LGL 2022). The low and high range of threshold distances shown are for detonation of for 5- and 1,000-pound UXOs, respectively, as modeled by Hannay and Zykov (2022). Detonation impacts could occur anywhere within the RWF and/or along the RWEC corridor, depending on where UXOs are identified.

Hearing generalist species have a swim bladder that is not directly involved in hearing. Species in this group may also use sound to communicate (Ladich and Schultz-Mirbach 2016; Popper et al. 2014). Examples of hearing generalists that occur in the RWF and RWEC include ocean pout, sturgeon, butterfish, scup, and tunas. While the presence of a swim bladder makes these species susceptible to sound-related injury, they are less vulnerable than the hearing specialists. Impact pile driving is the only source of construction noise likely to cause injury in this group, affecting individuals within approximately 2,470 to 3,683 feet and 2,756 to 3,458 feet of WTG and OSS monopile installation, respectively (see Table 3.13-5).

Fish that lack a swim bladder are the least vulnerable to noise impacts. While they have hearing organs and are susceptible to hearing injury, the lack of a swim bladder makes them less vulnerable to internal injuries leading to death (Popper et al. 2014). Examples of species in this hearing group that occur in the RWF and RWEC include flatfishes (e.g., summer, winter, and yellowtail flounder), skates (e.g., little, barndoor, and winter skate), and sharks (e.g., sand tiger, tiger, and sandbar shark). For this group, monopile installation is the only activity likely to cause injury-level noise effects from cumulative exposure within approximately 604 to 856 feet and 617 to 797 feet of WTG and OSS monopile installation, respectively (see Table 3.13-5).

Fish eggs and larvae are potentially susceptible to injury and mortality from intense underwater noise. While available evidence is limited, Popper et al. (2014) defined injury criteria for eggs and larvae that are used in this EIS to evaluate potential effects on both finfish (see Table 3.13-4). Impact pile driving and UXO detonation are the only construction noise sources likely to produce injury-level effects on eggs and larvae. This level of effect could occur within approximately 2,470 to 3,683 feet and 2,756 to 3,458 feet of WTG and OSS monopile installation, respectively, and within 148 to 1,384 feet of UXO detonations, depending on the size of the device. The significance of these impacts will vary depending on when the impacts occur and proximity to important spawning habitats. The instantaneous injury exposure area (area within which modeled underwater noise from a single monopile installation is above the injury threshold for fish eggs and larvae) is relatively small (within a few thousand feet of each site). Stationary eggs and larvae within this area would likely experience higher than natural levels of mortality. Although mortality-level effects on fish eggs and larvae could occur, these impacts are likely to be **minor** adverse overall because 1) the area of effect is small relative to the available habitat; 2) the loss of individuals would likely be insignificant relative to natural mortality rates for planktonic eggs and larvae across the GAA, which can range from 1% to 10% per day or higher (White et al. 2014); and 3) proposed TOY restrictions for pile driving (January through April and December with contingencies) could reduce the amount of Atlantic cod eggs and larvae exposed to injurious levels of pile-driving noise.

As stated, Revolution Wind has identified 16 UXOs in the RWEC corridor, all of which can be avoided by rerouting cable installation. Therefore, UXO detonation is not currently anticipated. However, it is possible that additional devices could be discovered during construction that could require detonation in place. Although this is unlikely, BOEM is providing an evaluation of potential UXO detonation effects on finfish should it be required. UXO detonations within the central portion of the Lease Area would be a concern if they occurred in proximity to sensitive habitats or life stages, such as Atlantic cod spawning. The central portion of the RWF encompasses large areas of continuous, large-grained and complex habitats, including medium- and low-density boulder fields, that recent evidence has indicated support spawning cod (Van Hoeck et al. 2023). Direct mortality, disturbance of spawning cod aggregations, and extensive damage to complex habitats (including attached fauna and epifauna present that may support adult cod) from UXO detonations are a concern because both Atlantic cod stocks (i.e., Gulf of Maine and Georges Bank) are considered overfished, but fishing rates established under rebuilding plans promote population growth (NOAA 2023). However, the status of cod populations and of spatiotemporal distribution of spawning in this region is not as well understood as other regions in the northwestern Atlantic (e.g., Gulf of Maine and Georges Bank). The infrequency of cod observed in fishery-independent trawl surveys contributes to the poor understanding of stocks in this region (Langan et al. 2020). Although, there is information indicating that, unlike other spawning stocks, cod in southern New England have increased in abundance during the last 20 years (Langan et al. 2020), and cod in this region have shown a tendency to be distributed over larger areas (Loehrke 2014). Existing and emerging data also indicate that cod spawning occurs throughout the southern New England region (DeCelles et al. 2017; Inspire Environmental 2019a, 2020; Van Hoeck et al. 2023). UXOs detonated within the RWEC-RI would also be a concern if they occur near juvenile cod HAPC (i.e., areas with cobble and pebble substrates) present within the RWEC-RI. Additional information regarding the specific benthic habitat (i.e., bedform features and classifications), as well as biogenic features and habitat-forming organisms found within the central portion of the Lease Area and the RWEC in Rhode Island state waters, is provided in the EFH assessment report (BOEM 2023c, 2023d).

Noise impacts on fish are likely to vary by species depending on general sensitivity to sound and how noise impacts overlap with sensitive life stages. Studies of fish response to noise impacts from seismic survey equipment provide a useful basis for evaluating the effects of potential exposure to sound sources like impact pile driving and UXO detonation. Seismic air guns used to map seafloor geology for oil exploration produce high-intensity impulsive sound comparable to or exceeding that produced by impact pile driving. Meekan et al. (2021) studied the behavioral responses of demersal finfish to repeated exposure to seismic survey noise and found no significant impacts to population and community structure, behavior, and distribution compared to reference sites. Although this effort studied a different fish community in western Australia, the results may be instructive here. The finding of no significant impact on fish population biology or community structure suggests that, for many fish species, noise impacts from impact pile driving and UXO detonation are likely to be short term and localized.

Noise impacts could be greater if they occur in important spawning habitat, occur during peak spawning periods, and/or result in reduced reproductive success in one or more spawning seasons. This could in theory result in long-term effects to populations if one or more year classes suffer suppressed recruitment. Alteration of the ambient noise environment could interfere with this ability, leading to potentially significant effects varying by species. For example, monopile installation is the most extensive and longest duration source of noise impacts and the most likely to cause adverse effects on Atlantic spawning cod.

Southern New England, including Cox Ledge, is known to support cod spawning aggregations (Clucas et al. 2019) during the winter months, but the status of cod populations and of spatiotemporal distribution of spawning in this region is not as well understood as other regions in the northwestern Atlantic (e.g., Gulf of Maine and Georges Bank). The infrequency of cod observed in fishery-independent trawl surveys contributes to the poor understanding of stocks in this region (Langan et al. 2020). However, there is information indicating that, unlike other spawning stocks, cod in southern New England have increased in abundance during the last 20 years (Langan et al. 2020), and cod in this region have shown a tendency to be distributed over larger areas (Loehrke 2014). Existing data also indicate that cod spawning occurs throughout the Southern New England region (DeCelles et al. 2017; Inspire Environmental 2019a, 2020; Van Hoeck et al. 2023).

Atlantic cod continue to be managed in U.S. waters as two units: the Gulf of Maine and the Georges Bank management units. An Atlantic Cod Stock Structure Working Group formed in 2018 recently carried out a multidisciplinary evaluation of cod structure in U.S. waters and identified a number of mismatches between the current management units and biological stock structure. Using evidence from an evaluation of early life history characteristics, an examination of genetic analyses, fishermen's ecological knowledge, and tagging studies, the working group concluded that cod in southern New England represent a unique biological stock, with demographics that are largely independent of neighboring populations (McBride and Smedbol 2022). In general, tagging studies have indicated that spawning groups in southern New England are largely sedentary (Loehrke 2014) and exhibit a high degree of residency; although, some tagging efforts have indicated extensive movements of cod from the Great South Channel to the western Gulf of Maine, with some movement into southern New England (Loehrke 2014; McBride and Smedbol 2022; O'Brien and Worcester 2009; Tallack 2009, 2012; Lui 2019; Wise 1963). A subsequent working group convened by the New England Fisheries Management Council is currently reviewing the available data and evaluating whether cod in southern New England should be managed as a discrete stock. A decision to recognize cod in southern New England (and other regions in the Northeast) as a unique biological stock will have downstream fisheries management implications, including the development of new stock/population assessments, that would allow fisheries managers to better understand and work toward rebuilding overfished Atlantic cod populations.

The presence of spawning cod has been documented in and near the RWF from October through March (Inspire Environmental 2019a, 2020; Van Hoeck et al. 2023). Van Hoeck et al. (2023) recorded peaks in grunt detections from an inferred spawning aggregation in November through December within the central portion of the Lease Area (i.e., Zone RWF 1) between 2013 and 2015. Spawning maturation data from cod captured via hook and line both within and outside the RWF (i.e., areas to the south and west) have found spawning-condition cod (both males and females) from December through March. These data indicate that pile driving could occur when maturing and mature spawning cod are present near the maximum work area during a portion of their spawning season. However, it is unknown what proportion of cod spawning sites in southern New England is present within the RWF, and it is unclear if the central portion of the RWF (i.e., Zone RWF 1) still supports the spawning aggregation observed to occur from data collected between 2013 and 2015 (Van Hoeck et al. 2023). Subsequent acoustic surveys in the central portion of Zone RWF 1 yielded minimal grunt detections in November (n = 2) between 2020 and 2022, and it is unclear whether this is indicative of the absence of the spawning aggregation or if this is due to insufficient sampling stations (Van Hoeck et al. 2023). A separate and potential contributing factor to the lack of recently observed spawning activity may be associated with ongoing commercial and recreational fishing of Atlantic cod within the Lease Area and throughout the southern New England region during the spawning season.

Per the Final EIS's temporal impacts definitions shown in Table 3.3-4, pile driving is considered a short-term temporary impact in which the effects (i.e., sound) would end when the activity ceases. Impact pile driving would not occur for 24 hours a day over the course of 5 months. Rather, pile driving would occur for up to 12 hours during any 24-hour period over the course of 5 months (i.e., May through December) and would not be conducted concurrently (i.e., more than one monopile installed simultaneously). Assuming ideal conditions under the Proposed Action (i.e., the installation of 100 WTGs), it would take approximately 36 days to install all WTGs and OSSs. The actual installation rates are likely to be lower due to a variety of factors, including weather delays, EPM and mitigation compliance, equipment malfunctions, supply chain constraints, and crew availability (e.g., COVID limitations). Although foundations installation could extend into November and December, it would likely be limited to a small number of foundations that were previously delayed. The number and duration of pile-driving events occurring in November and December, if any, would likely be limited.

Nevertheless, underwater sound from pile driving could impact Atlantic cod, hake, and black sea bass, which belong to the hearing specialist group and rely on sound for communication and other important behaviors (Rowe and Hutchings 2006; Stanley et al. 2020). Stanley et al. (2020) determined that impulsive underwater noise from activities like impact pile driving could interfere with black sea bass communication during spawning but concluded that they would likely return to normal spawning behavior once the impact ceased. In a separate study, Stanley et al. (2022) found that in a controlled environment, the effect of replayed pile-driving sound resulted in decreased swimming and increased resting behavior in non-spawning black sea bass; however, opportunistic observations of the same sampled black sea bass revealed spawning within 1 month of exposure to pile-driving sounds. Other species, such as Atlantic cod, may be more sensitive to noise impacts. Some researchers have observed or speculated that Atlantic cod could suspend spawning and even abandon preferred spawning habitats when exposed to intense disturbance associated with commercial fishing activity or sound associated with seismic surveys (Andersson et al. 2017; Dean et al. 2012; Engås et al. 1996; Mueller-Blenke et al. 2010). In contrast, other research on the effects of impulsive seismic survey sound that can last weeks to months has indicated that this level of behavioral response is unlikely (McQueen et al. 2022; Meeken et al. 2021). For example, Meekan et al. (2021) observed no short-term (days) or long-term (months) effects of exposure to the composition, abundance, size structure, behavior, or movement to assemblages of tropical demersal fishes, including hearing specialist species (e.g., *Lutjanidae* sp.), in Western Australia exposed to noise from a commercial-scale seismic air gun survey with received SELs of up to approximately 180 dB re 1 μPa2·s. McQueen et al. (2022) examined the responses of spawning cod in the North Sea exposed to seismic air gun noise over two 1-week periods, with fluctuating SELs of up to 145 dB re 1 μPa2·s, comparable to a full-scale industrial survey 5 to 40 km away (Handegard et al. 2003). Tagged cod in this study were found not to be displaced from spawning grounds (McQueen et al. 2022). McQueen et al. (2022) speculated that strong affinity to selected spawning sites overcame the behavioral effects of stressor exposure. Although the sound source (i.e., seismic air guns) is not analogous to pile driving, they both produce high-intensity, impulsive sound primarily in the approximately 100-Hz or lower frequency bands that overlap the spectral range of cod communication and hearing sensitivity and are informative in the absence of studies assessing the impacts of pile driving to Atlantic cod.

Overall, these findings suggest that, although noise exposure during sensitive life stages is a potential concern, disturbances resulting from impulsive sound sources, such as pile driving or seismic air guns, may not necessarily result in adverse effects, such as the complete abandonment of an area for the duration of a spawning season versus temporary displacement or disturbance of Atlantic cod or other hearing specialist species. It is expected that sound attenuation systems, such as bubble curtains, would be used to reduce received SELs from pile-driving noise. However, even with sound attenuation systems, monopile installation is still the largest acoustic impact from the Proposed Action. Van Hoeck et al (2023) found that, based on temporal patterns of Atlantic cod grunts, spawning in southern New England waters is concentrated in November and December, which partially overlaps the timeline of construction.

Although there remain some data gaps regarding spawning cod response to pile driving, empirical studies with cod and seismic surveys and recent work with black sea bass and pile driving suggest that any responses are likely temporary. Additional studies to better understand the spatiotemporal dynamics and habitat use of spawning Atlantic cod in and near the RWF are ongoing (BOEM 2021a).

Other hearing specialist species could be exposed to construction noise, but the consequences of exposure would vary depending on multiple factors. For example, monkfish spawn between May and December but do so over broad areas and likely multiple times per year (Johnson et al. 2008). Red hake spawn in the summer, and the RWF and RWEC are located within a broader area identified as a hotspot for spawning and larval dispersal (NEFSC 2020). However, unlike cod, red hake spawns in the water column and does not associate with specific benthic habitats, and therefore has less potential for direct noise exposure.

The potential for other construction noise sources, such as vessel engines and HRG surveys, to negatively impact cod and related species is less clear. Although construction vessel noise (e.g., engine vibration, propeller cavitation) could occur during cod spawning in winter and early spring, vessel noise is lower in volume than impact pile-driving noise. As noted above, cod have continued to display high fidelity to spawning sites on Cox Ledge despite the ambient noise levels present in this environment. In this context, vessel use is not likely to significantly alter the ambient noise environment relative to the existing baseline. This suggests that any impacts on cod spawning could be limited in extent and duration and short term minor adverse with respect to HRG surveys and construction vessel noise.

Underwater sound from vessels can cause avoidance behavior, which has been observed for Atlantic herring and Atlantic cod and is a likely behavior of other species (Handegard et al. 2003; Vabø et al. 2002). Fish may respond to approaching vessels by diving toward the seafloor or by moving horizontally out of the vessel's path, with reactions often initiated well before the vessel reaches the fish (Berthe and Lecchini 2016; Ona et al. 2007). The avoidance of vessels by fish has been linked to high levels of infrasonic and low-frequency sound (approximately 10–1,000 Hz) emitted by vessels. Accordingly, it was thought that quieter vessels would result in less avoidance (and consequently quieter vessels would have a higher chance of encountering fish) (De Robertis et al. 2010). By comparing the effects of a quieted vessel to the effects of a conventional research vessel on schooling herring, it was found that the avoidance reaction initiated by the quieter vessel was stronger and more prolonged than the one initiated by the conventional vessel (Ona et al. 2007). In a comment to this publication, Sand et al. (2008) pointed out that fish are sensitive to particle acceleration and that the cue in this case may have been low-frequency particle acceleration caused by displacement of water by the moving hull. This could explain the stronger response to the larger, noise-reduced vessel in the study by Ona et al. (2007), which would have displaced more water as it approached.

Nedelec et al. (2016) investigated the response of reef-associated fish by exposing them in their natural environment to playback of vessel engine sounds. They found that juvenile fish increased hiding and ventilation rate after a short-term vessel sound playback, but responses diminished after long-term playback, indicating habituation to sound exposure over longer durations. These results were corroborated by Holmes et al. (2017) who also observed short-term behavioral changes in juvenile reef fish after exposure to vessel noise as well as desensitization over longer exposure periods. Although sounds emitted by vessel activity are unlikely to injure fish, vessel sound has been documented to cause short-term behavioral responses (Holmes et al. 2017).

Analysis of vessel noise related to the Cape Wind Energy Project estimated that noise levels from construction vessels at 10 feet (3 m) were loud enough to elicit an avoidance response but not loud enough to do physical harm (MMS 2008). Pelagic species and life stages and prey species that occur high in the water column (e.g., Atlantic butterfish, Atlantic herring, Atlantic mackerel, bluefish, and some highly migratory pelagic species) would be the most likely impacted species by vessel and construction noise, although the behavioral avoidance impacts would be short term. However, in inshore shallow waters, benthic species and life stages could also be impacted. Any disturbance they did experience would result in a short-term impact of avoidance of vessel noise. Therefore, finfish within the Lease Area and RWEC corridor may initially exhibit a negative behavioral response to vessel activity; however, as vessel traffic increases throughout the previously discussed Project timeline, habituation to vessel noise by finfish is likely to occur. Project-related vessel noise would be intermittent and of short duration, so the overall impacts to fish are expected to be negligible.

However, these effects must be considered against the baseline levels of vessel traffic. Thousands of commercial and recreational vessel trips pass through the RI/MA WEA every year (see Section 3.16). Additionally, commercial and recreational fishing activity in and around the RWF likely generates hundreds of vessel trips and thousands of operational hours on an annual basis. In this context, construction and installation vessel use is not likely to significantly alter the ambient noise environment relative to the existing baseline. While construction and installation–related vessel noise could induce physiological stress responses or avoidance behaviors and could result in auditory masking of biologically significant sounds, BOEM anticipates that short-term exposure to vessel noise would not measurably alter normal behavior patterns.

As discussed in the No Action Alternative, construction of the Project could affect the Atlantic sturgeon, shortnose sturgeon, and the giant manta ray primarily through exposure to harmful levels of underwater noise during foundation installation as well as behavioral exposure from noise produced by preconstruction HRG surveys. NMFS uses different underwater noise impact criteria to assess potential underwater noise impacts on ESA-listed fish species (FHWG 2008). Adult and subadult endangered Atlantic sturgeon are expected to occur in the offshore waters of the Mid-Atlantic OCS throughout the year but appear to be present in lower numbers in the summer (Dunton et al. 2015; Ingram et al. 2019; Savoy and Pacileo 2003; Stein et al. 2004). This indicates that ESA-listed Atlantic sturgeon could be exposed to Project-related noise impacts.

The most prominent impacts on Atlantic sturgeon are expected from exposure to pile-driving noise. Although individuals from the five DPSs of ESA-listed Atlantic sturgeon could be affected by the Proposed Action, which could include impacts up to and including injury or mortality. Individuals from these DPSs could be exposed to any of the effects described above on benthic habitats and finfish that are pertinent to demersal fish species. Individual animals could be exposed to potential effects ranging from short-term behavioral disturbance to short-term or permanent hearing threshold shifts, to barotrauma injury or mortality from exposure to intense underwater noise from impact pile driving and UXO detonation. Most underwater noise impacts would be limited to short-term behavioral alteration.

Shortnose sturgeon could be exposed to impact pile-driving noise from RWF construction during installation of sheet pile cofferdam for the sea-to-shore transition and could also be exposed to underwater noise from UXO detonation and RWEC construction activities in Narragansett Bay. Shortnose sturgeon have not been reliably documented in Narragansett Bay. However, as stated previously, individuals from the nearby Connecticut River population could occur in Narragansett Bay based on observed migratory patterns between other river systems in New England (Dionne et al. 2013; Fernandes et al. 2010).

In summary, Project construction is likely to result in short-term to long-term noise impacts sufficient to cause a range of effects on finfish. The significance of these effects is likely to vary by species, depending on the number of individuals exposed and the degree to which noise impacts might interfere with important biological functions like spawning. EPMs committed to by Revolution Wind (see Table F-1, Appendix F), including ramp-up/soft starts and TOY restrictions for pile-driving activity (January through April), would reduce the magnitude and temporal extent of impacts to Atlantic cod spawning, which existing data indicate is occurring both within (primarily in Zone RWF 1) and outside the Lease Area between October and March (DeCelles et al. 2017; Inspire Environmental 2019a, 2020; Van Hoeck et al. 2023). In addition, Revolution Wind would coordinate with Rhode Island Department of Environmental Management (RIDEM) and NOAA NMFS regarding TOY restrictions through the permitting process and would adhere to requirements imposed by these agencies (e.g., TOY restrictions to avoid and/or minimize impacts to winter flounder). On balance, construction noise impacts on finfish would likely range from **minor** to **moderate** adverse.

Presence of structures: The impacts resulting from installed foundations would be similar to those described above in the anchoring and new cable placement/maintenance IPF. Juvenile and adult fish are mobile and would likely avoid being harmed or killed by construction equipment and materials placement. In contrast, certain fish species, such as cod, ocean pout, Atlantic pollock, and winter flounder, have benthic eggs and/or larvae that would be vulnerable to these effects. The extent of exposure would vary by species and habitat association. Some individual finfish would unavoidably be injured or killed, but the number of individuals affected would be insignificant relative to the size of the population and the resource would recover completely without additional mitigation. Therefore, effects to finfish from construction of structures would be **negligible** adverse.

Sediment deposition and burial: The Project would result in short-term, elevated levels of suspended sediment near major bed-disturbing activities like cable installation. Anticipated water column sediment concentrations and burial depths resulting from this impact mechanism are described in Table 3.6-8, Section 3.6.2.3.2. TSS concentrations of the magnitude and duration anticipated are below levels associated with measurable adverse effects on finfish (Wilber and Clarke 2001; Yang et al. 2017) and would therefore be negligible. Juvenile and adult finfish associated with benthic habitats are unlikely to be significantly affected by sediment deposition at the burial depths anticipated, but benthic eggs and larvae of some species could be harmed (Kjelland et al. 2015; Michel et al. 2013; Wilber and Clarke 2001). While sensitivity varies widely, the eggs and larvae of some species can be killed by as little as 0.4 inch (10 mm) of sediment deposition. The eggs of certain species, like winter flounder, are particularly sensitive and can be killed by burial depths less than 0.1 inch (3 mm) (Michel et al. 2013). While some adverse effects would undoubtedly occur, the extent of deposition and burial impacts is small relative to the amount of egg and larval settlement habitat available, and the duration of those impacts would be short term (hours to days). As described previously for larval entrainment, lethal burial of even several thousand eggs and larvae would be biologically insignificant relative to the number of eggs and larvae in the environment and natural mortality rates. Given the short-term nature of the impact and the limited extent of significant burial effects relative to the amount of habitat available, burial effects on benthic eggs and larvae would be short term and expected to recover without remedial or mitigating action and therefore **minor** adverse.

3.13.2.4.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Accidental releases and discharges: Potential impacts to finfish from accidental releases and discharges during O&M and decommissioning of the Project would be similar to and less than those described under construction and installation because the volumes of fuels and oils and number of vessels required during O&M and decommissioning would be less than that required during construction and operations (Section 3.21.2.2.2). As described for construction and installation, accidental releases that could occur during O&M and decommissioning would be infrequent and **negligible** adverse. In the unlikely event of a large accidental spill, impacts to finfish would similarly range from **minor** to **moderate** adverse depending on the size and timing of the event, the nature of the material evolved, the extent and duration of species exposure, and the necessary response measures used. As an example, Atlantic cod eggs float near the surface and are abundant in and near the RWF site from February to April (NEFMC 2017). A high-volume spill of toxic material that disperses on the water surface during this period could injure or kill large numbers of cod eggs, adversely affecting year class recruitment.

Anchoring and new cable emplacement/maintenance: As stated in Section 3.5.2 of the COP, the Project does not anticipate that the IAC, OSS-link cable, and RWEC would require routine maintenance. The cables themselves would be unlikely to require repair but up to 10% of cable protection could need to be replaced over the life of the Project. Cable repair and maintenance, replacement of scour protection, spill response, and other O&M activities could require vessel anchoring. Anchoring would result in short-term, localized impacts to benthic habitat similar to those described for Project construction but reduced in scale and dispersed over the operational life of the Project. Cable protection maintenance and the eventual decommissioning and removal of buried cables would produce similar effects on finfish as those described for Project construction in Section 3.13.2.2.1. These would include direct disturbance of the seafloor, suspended sediment deposition in the surrounding area, and injury and displacement of finfish using these habitats. It is anticipated that these activities would result in short term **minor** adverse impacts to finfish.

EMF: Table 3.6-10 in Section 3.6.2.3.2 summarizes potential EMF and substrate heating exposure for benthic invertebrates from Project operations. Those findings are also applicable to demersal finfish. The EMF values displayed are the estimated maximum values that would occur at the seafloor directly over the cable. EMF strength would diminish rapidly with distance, becoming undetectable within approximately 30 feet of the cable path (Exponent 2023). The most intense EMF effects would occur immediately above exposed RWEC segments laid on the seafloor surface and covered by an armoring blanket.

Hutchison et al. (2020b) reviewed available research on the sensitivity of various finfish species to EMF effects. They concluded that the available knowledge base on EMF effects on fish is insufficient to fully evaluate potential EMF effects from the widespread development of offshore renewable energy. Behavioral responses have been observed in some fish species exposed to EMFs, but clear relationships have yet to be established. Researchers studying EMF effects on fish have identified observable effects but usually at test exposures ranging from tens to hundreds of times greater than the strongest exposures likely to result from the Project. The type of power source is also an important factor. HVAC produces a different type of field effect from HVDC that may not be as detectable by electrosensitive fish species.

BOEM has evaluated the potential sensitivity of commercially and recreationally important fish species to likely EMF levels generated by commercial wind farm transmission cables on the OCS (Normandeau et al. 2011; CSA Ocean Sciences Inc. and Exponent 2019). CSA Ocean Sciences Inc. and Exponent (2019) determined that most fish species would not be able to detect EMF from HVAC transmission cables, and those species that are able to detect EMFs would not experience significant physiological or behavioral effects. All currently proposed offshore wind energy projects, including the Proposed Action, would employ HVAC transmission exclusively. The preponderance of available research on a variety of fish species (e.g., Armstrong et al. 2015; Bevelhimer et al. 2013; Orpwood et al. 2015) indicates that the minimum magnetic field exposure threshold for observable effects on behavior exceeds 1,000 milligauss (mG) for most fish species. The minimum threshold for observable detection of low-frequency (less than 10 Hz) electrical fields in electrosensitive fish species is on the order of 20 millivolt/meter (mV/m) (Basov 1999). Each of these thresholds is an order of magnitude greater than the maximum potential EMF effect likely to result from Project operation. In addition, these thresholds are representative of sensitivity to very low frequency bioelectric or direct current electrical fields. Given this, they are likely not representative of sensitivity to EMFs generated by HVAC transmission at 60 Hz, which is not detectable by many finfish species.

These findings support the conclusions of Normandeau et al. (2011) that the magnetite-based sensory organs of fish are unable to detect AC magnetic fields below 50 mG. The minimum thresholds for observable physiological and behavioral effects in available research are much higher than the minimum detection threshold suggested by Normandeau et al. (2011), on the order of 250 to over 1,000 mG. In a more recent review of EMF effects produced by offshore wind energy, Gill et al. (2020) concluded that HVAC-induced electrical fields in fish on the order of those produced by the Project would unlikely result in observable effects on physiology or behavior. Although EMF and substrate heating effects would vary depending on transmission voltage and the position of the cable on the seafloor (i.e., buried to target depth or laid on seafloor surface), those effects are unlikely to result in more than minor effects on finfish behavior.

Calculated magnetic and electrical field effects for buried and exposed segments of the IAC for average loading are summarized in Table 3.13-6. Calculated magnetic and electrical field effects for buried and exposed segments of the RWEC for average loading are summarized in Table 3.13-6. A summary of applicable EMF effect thresholds from available research are summarized by species and life stage group in Table 3.13-7 and are applied here to evaluate potential EMF effects on finfish.

Table 3.13-6. Modeled Electromagnetic Field Levels and Estimated Substrate Heating Effects Under Average and Peak Load Conditions for Buried and Exposed Cable Segments and Miles of Cable by Category for the Proposed Action

Component	Installation	Total Cable Length (linear miles)	Magnetic Field (mG) at Seafloor	Magnetic Field (mG) 3.3 Feet above Seafloor	Electrical Field (mV/m @60 Hz) at Seafloor	Electrical Field (mV/m @60 Hz) 3.3 Feet above Seafloor	Substrate Heating
IAC	Buried to 3.3 feet	104.5	57	17	2.1	1.3	+10 to +20°C within 0.4 to 0.6 m of cable
	On seafloor surface	11.6	522	21	5.4	1.7	Negligible
OSS-link cable	Buried to 3.3 feet	8.4	147	41	4.4	2.3	+10 to +20°C within 0.4 to 0.6 m of cable
	On seafloor surface	0.9	1,071	91	13	1.6	Negligible
RWEC[†]	Buried to 3.3 feet	70.6	147–210	41	4.4	2.3	+10 to +20°C within 0.4 to 0.6 m of cable
	On seafloor surface	12.7	1,071–1,529	91	13	1.6	Negligible

Table 3.13-7. Magnetic and Induced Electrical Field Levels Used to Evaluate Potential Electromagnetic Field Effects on Finfish

Species and Life Stage Group	Type of Effect	Magnetic Field	Induced Electrical Field (mV/m)	Source
Fish eggs and larvae	Survival and development	> 1,000 mG	> 500 mV/m	Brouard et al. (1996); Cameron et al. (1985)
Finfish	Physiological and behavioral	> 950 mG	20 mV/m	Armstrong et al. (2015); Basov (1999); Bevelhimer et al. (2013); Orpwood et al. (2015)

Species and Life Stage Group	Type of Effect	Magnetic Field	Induced Electrical Field (mV/m)	Source
Sharks and skates	Behavioral	250–1,000 mG	< 2–5 mV/m*	Bedore and Kajiura (2013); Hutchison et al. (2020a); Kempster et al. (2013)

* This threshold only applies to induced electrical fields at frequencies below 20 Hz; the 60-Hz induced electrical field from the HVAC IAC and RWEC would likely not be detectable by sharks, skates, and rays (Bedore and Kajiura 2013).

Atlantic sturgeon are electrosensitive but appear to have a relatively low sensitivity to magnetic fields based on studies of other sturgeon species. Bevelhimer et al. (2013) studied behavioral responses of lake sturgeon to artificial EMF fields and identified a magnetic field detection threshold between 10,000 and 20,000 mG, well above the levels likely to result from the Proposed Action (i.e., 57–522 mG above the IAC and 147–1,071 mG on the seafloor surface above the buried and exposed RWEC and OSS-link). This indicates that Atlantic sturgeon are likely insensitive to magnetic field effects resulting from the Proposed Action.

Sturgeon may, however, be able to detect the induced electrical field generated by transmission cables. Atlantic sturgeon have specialized electrosensory organs capable of detecting electrical fields on the order of 0.5 mV/m (Gill et al. 2012; Normandeau et al. 2011). Exponent (2023) calculated that the maximum induced electrical field strength in Atlantic sturgeon from the RWF IAC and the RWEC would be 0.7 mV/m or less, slightly below the detection threshold for the species. However, this analysis only considered the field associated with buried cable segments. Based on magnetic field strength, the induced electrical field in sturgeon near exposed cable segments is likely to exceed the 0.5-mV/m threshold. This suggests that Atlantic sturgeon would likely be able to detect the induced electrical fields in immediate proximity to exposed cable segments. Sturgeon species have been reported to respond to low-frequency AC electric signals. For example, migrating Danube sturgeon (*Acipenser gueldenstaedtii*) have been reported to slow down when crossing beneath overhead high-voltage cables and speed up once past them (Gill et al. 2012). This is not a useful comparison, however, because overhead power cables are unshielded and generate relatively powerful induced electrical fields compared to shielded submarine cables. Insufficient information is available to associate exposure to induced electrical fields generated by submarine cables with measurable behavioral or physiological effects (Gill et al. 2012). However, it is important to note that natural electrical field effects generated by wave and current actions are on the order of 10 to 100 µV/m, many times stronger than the induced field generated by buried cable segments. Given the range of baseline variability and limited area of detectable effects relative to available habitat on the OCS, the effects of Atlantic sturgeon exposure to Project-related EMF are therefore likely to be discountable.

Manta rays are elasmobranchs, a group of fishes with specialized electrosensory organs that allow these species to detect the low-intensity bioelectric signals generated by other aquatic organisms. Bedore and Kajiura (2013) reviewed the electrosensitivity of several elasmobranch species and determined detection thresholds ranging from 20 to 50 µV/m and detection distances of approximately 1.6 feet (50 cm) for most of the species tested. It is important to note that these species primarily included predators that forage on benthic organisms. Manta rays are pelagic filter feeders that are presumably less reliant on their electrosensory organs to detect prey, suggesting they are likely on the lower end of this sensitivity range. Given that manta ray occurrence in the marine component of the GAA is rare, and this species is most commonly distributed higher in the water column away from the seafloor, the likelihood of measurable effects on manta rays from exposure to Project-related EMF is discountable.

The Project includes EPMs to minimize EMF impacts and would employ HVAC transmission, which generally produces lower intensity EMF than HVDC. All transmission cables would be contained in grounded metallic shielding to minimize electrical field effects and buried to target depths of 4 to 6 feet (1.2 to 1.8 m) in soft-bottom benthic habitat and other areas where burial is possible. Cable segments that cross unavoidable hard substrates and other offshore infrastructure would not be buried and would be laid on the seafloor surface covered with a concrete mattress or other form of cable armoring for further protection. EMF effects in these areas would be greater than for buried cable segments. The maximum possible magnetic field, directly adjacent to unburied sections of the RWEC (8.8 miles), is expected to be 1,071 mG, which diminishes to 91 mG at a distance of 3.3 feet (1 m) (see Table 3.6-10) (Exponent 2023). Rapid dissipation of EMF over distance therefore means that the effects are highly localized.

Hughes et al. (2015) and Emeana et al. (2016) evaluated the thermal effects of buried and exposed electrical transmission cables on the surrounding environment. They determined that heat from exposed cable segments would dissipate rapidly without measurably heating the underlying sediments. In contrast, the typical HVAC cable buried in sand and mixed sand and mud (i.e., soft-bottom benthic habitat) can heat sediments within 1.3 to 2 feet (0.4 to 0.6 m) of the cable surface by +10 to 20°C. The anticipated extent of EMF and substrate heating effects from Project operations are the same as those summarized for benthic invertebrates in Section 3.6.2.3.2.

Substrate heating impacts generated by the IAC and RWEC are not likely to significantly affect finfish for the same reasons described for invertebrates in Section 3.6.2.3.2. Targeted research conducted by Hughes et al. (2015) and Emeana et al. (2016) indicate that substrate heating effects from buried cable segments at the minimum depths proposed for the Project are unlikely to be measurable within 2 feet of the seafloor surface. As such, these effects would not be detectable to fish on or burrowed into the seafloor surface at depths less than 2 feet. Substrate heating effects could reach the seafloor surface at transition points between buried and exposed cable segments. However, these transition areas and exposed cable segments would be covered by porous concrete mattresses or other forms of cable protection, limiting fish access. Small fishes using the interstitial spaces within the mattresses may be able to detect some cable heating effects, but only within the transition zones described.

These findings indicate that long-term EMF effects would likely be below detectable levels for finfish. Some electrosensitive species (such as sharks, skates, and rays) occurring in the immediate proximity of exposed cable segments may be able to detect EMF levels sufficient to alter their behavior, including inducing more rapid swimming, more frequent direction changes, and avoidance (Hutchison et al 2018). The exclusive use of 60 Hz AC in underwater transmission cables for offshore wind is not expected to induce significant behavioral responses in electrosensitive animals. Effects of this magnitude would occur within a few inches to feet of the cable surface, limiting these effects to a small number of individuals that occur near the cable surface. Given the short-term nature of these behavioral effects and the limited extent of exposure, effects to finfish are likely to be **minor** adverse.

<u>Noise</u>: The RWF would employ current generation direct drive WTG designs that generally produce less underwater noise and vibration than older generation WTGs with gearboxes. Much of our current understanding about operational noise is based on the monitoring of wind farms in Europe that use older generation designs. Although useful for generally characterizing potential noise effects, these data are not necessarily representative of the noise produced by current generation designs (Elliot et al. 2019; Tougaard et al. 2020). Typical noise levels produced by older generation geared WTGs range from 110 to 130 re 1 µPa with 1/3-octave bands in the 12.5- to 500-Hz range, sometimes louder under extreme operating conditions (Betke et al. 2004; Jansen and de Jong 2016; Madsen et al. 2006; Marmo et al. 2013; Nedwell and Howell 2004; Tougaard et al. 2009, 2020). More recently, Stober and Thomsen (2021) used monitoring data and modeling to estimate operational noise from larger (10 MW) current generation direct drive WTGs and concluded that these designs could generate higher operational noise levels than

those reported in earlier research. This suggests that operational noise effects could be more intense and extensive than those considered herein, but additional research is needed.

Elliot et al. (2019) summarized findings of operational noise monitoring from the BIWF. The BIWF employs five 6-MW direct drive WTGs. Operational noise from the direct drive WTGs at the BIWF were generally lower than older, lower capacity WTGs at European wind farms. Operational noise levels typically ranged from 110 to 125 re 1 μPa, occasionally reaching as high as 128 re 1 μPa, mostly at low frequencies ranging from 10 Hz to 8 kHz. Particle acceleration effects on the order of 10 to 30 dB re 1 $\mu m/s^2$ at a reference distance of 50 meters. These values are considered usefully representative of the underwater noise effects likely to result from RWF operations.

Cod and other hearing specialist species are also potentially sensitive to particle motion effects. Elliot et al. (2019) compared observed particle motion effects at 164 feet (50 m) from an operational BIWF turbine foundation to current research on particle motion sensitivity in fish. They concluded that particle motion effects could occasionally exceed the lower limit of observed behavioral responses in Atlantic cod and flatfish within these limits. However, the documented use of complex habitats created by the structures by cod, black sea bass, and other hearing specialist species at the BIWF and European wind farms (Hutchison et al. 2020b; Methratta and Dardick 2019; Wilber et al. 2022a) indicates that low-level operational noise effects are not causing avoidance responses in hearing specialist species. These observational studies are supported by experimental research. For example, Kastelein et al. (2008) observed no apparent behavioral changes in cod exposed to experimental sounds comparable to operational noise from WTGs within a contained environment. As stated previously (see Section 3.16.2.2.1), Atlantic cod can be sensitive to changes in the ambient noise environment during spawning (Andersson et al. 2012; Dean et al. 2012; Engås et al. 1996; Mueller-Blenke et al. 2010; Rowe and Hutchings 2006). Although, a recent study investigating the impacts of intense low-frequency impulsive sound exposure (i.e., seismic air gun surveys) on spawning cod observed temporary disruption of spawning activity followed by rapid resumption of spawning activity at the same location once the stressor was removed (McQueen et al. 2022). They speculated that strong site affinity could explain the lack of a significant behavioral response to an otherwise intensive stressor. These contrasting findings suggest that short-term periods of disturbance may not necessarily result in adverse effects on Atlantic cod spawning.

Popper and Hawkins (2018) conclude that Atlantic cod, and probably many other fish species in the hearing specialist group, are sensitive to both sound pressure and particle motion and use both aspects of sound to assess and orient themselves in the three-dimensional aquatic environment. This ability likely enables fishes to locate particular sources of sound, such as prey or potential mates, and may also assist them in identifying and locating sounds from a particular source within the general ambient noise environment. The low-frequency operational noise produced by WTGs overlaps the communication frequencies used by cod and other hearing specialist species like haddock (Stanley et al. 2017). In theory, operational noise and particle motion effects from WTG operations could alter the background noise environment in ways that negatively impact the ability of hearing specialist fish species to characterize the ambient noise environment. However, hearing specialist species like Atlantic cod and black seabass readily use the BIWF and surroundings (Wilber et al. 2022a, 2022b), indicating that operational noise effects have not dissuaded hearing specialist species from using these environments. Some degree of habituation to these operational noise and particle motion effects is to be anticipated. Bedjer et al. (2009) argue that habituation of organisms to ongoing low-level disturbance is not necessarily a neutral or benign process. For example, habituation to particle motion effects could make individual finfish less aware of approaching predators, or could cause masking effects that interfere with communication, mating, or other important behaviors. Because of the limited number of studies using offshore wind farm noise, it is not known whether auditory masking actually occurs and has an effect on survival and reproduction within a wind farm area (Mooney et al. 2020).

Collectively, these findings suggest that Project operations could have limited adverse effects on habitat suitability for EFH species within a certain distance of each monopile foundation. The extent of these effects is difficult to quantify because they are likely to vary depending on wind speed, water temperature, ambient noise conditions, and other factors.

Revolution Wind (Tech Environmental 2023) has estimated that Project O&M would involve up to four CTV and two SOV trips per month, or 2,280 vessel trips over the life of the Project (see Section 3.15 for CTV and SOV operational noise details). Noise levels generated by the CTV are expected to be on the order of 160 dB re 1 $\mu Pa/sec^2$ at a reference distance of 1 meter based on observed noise levels generated by working commercial vessels of similar size and class to the CTVs (Kipple and Gabriele 2003; Takahashi et al. 2019). The SOV would produce similar noise levels to those described by Denes et al. (2021), on the order of 170 dB re 1 $\mu Pa/sec^2$. These values are below identified injury thresholds for all finfish hearing groups, indicating that CTV noise is unlikely to cause injury-level effects on any fish species. These values do exceed the 158-dB threshold for TTS effects on hearing specialist fish species, but this threshold assumes 24 hours of continuous exposure. An individual fish is unlikely to remain close enough to the moving vessel hull long enough for any risk of injury to occur. The 160 and 170 re 1 $\mu Pa/sec^2$ source levels could exceed the behavioral effects threshold for fish in proximity to the vessels in some cases, but those effects would be short term in duration and limited in extent. The low-frequency noise produced by the vessel engine could also cause similar auditory masking effects as those described above for WTG operations. However, these effects must be considered against the baseline levels of vessel traffic. In this context, O&M vessel use is not likely to significantly alter the ambient noise environment relative to the existing baseline.

Additionally, the relatively low-intensity, low-frequency sounds produced by Project survey vessels are unlikely to result in direct injury, hearing impairment, or other trauma to marine fish. Vessel noise could induce physiological stress responses or avoidance behaviors and could result in auditory masking of biologically significant sounds. However, due to the expected brief periods of exposure to vessel noise, BOEM anticipates that short-term exposure to vessel noise would not measurably alter normal behavior patterns and would therefore be **negligible** adverse.

These findings indicate that measurable operational noise would result from the Proposed Action, producing effects detectable by finfish. Those effects are likely to vary in significance by species depending on hearing sensitivity. Effects on species that lack a swim bladder, like sharks, rays, and flatfish, and hearing generalist species like ocean pout, sturgeon, butterfish, scup, and tunas, are likely to be biologically insignificant and therefore negligible. Operational noise could reduce the ability of hearing specialist species, like Atlantic cod, haddock, Atlantic pollock, and hake, to communicate effectively. However, this impact would only be expected to occur within a few hundred feet of each turbine (HDR 2019), and the likelihood of effects (e.g., negative effects on reproduction and survival) in the wild around operational offshore wind farms is unknown (Mooney et al. 2020). Therefore, the effects could range from negligible to minor adverse based on currently available information.

Decommissioning of the RWF and RWEC would lead to impacts similar to but less than those generated during construction because there would be no pile-driving impacts. During decommissioning, the monopile foundations would be cut below the seafloor surface using a cable saw. Pangerc et al. (2016) found that underwater noise levels produced by this type of equipment are difficult to distinguish from the associated construction vessel noise and are below levels that would cause injury or behavioral effects on fish. The impacts of short-term seafloor disturbance and water quality effects on fish would be similar to those caused by construction: **negligible** to **minor** adverse.

Presence of structures: The presence of monopile foundations and scour protection during Project O&M would create an artificial reef effect. The attractive effect of these artificial reefs on finfish is well documented (Degraer et al. 2020; Hutchison et al. 2020a; Kramer et al. 2015; Wilber et al. 2022a). In a meta-analysis of studies on wind farm reef effects, Methratta and Dardick (2019) observed an increase in the abundance of epibenthic and demersal fish species, while effects on pelagic species are less clear. Increased fish abundance around wind farm structures can also attract predators like seals (Russel et al. 2014).

Hutchison et al. (2020b) and Wilber et al. (2022a) documented a significant increase in the abundance of black sea bass, an EFH species, around the BIWF. This species is known to associate with complex benthic habitat and artificial reef structures and is clearly benefiting from the habitat and foraging opportunities created by the artificial reef effect. Several other fish species have also been observed in abundance, including EFH species like Atlantic cod, scup, bluefish, monkfish, winter flounder, and dogfish (Hutchison et al. 2020b; Wilber et al. 2022a). Atlantic striped bass and tautog, highly valued commercial and recreational fish species, have also been observed in abundance around the structures (Hutchison et al. 2020b; Wilber et al. 2022a). Similar changes in fish community structure would likely occur at the RWF as the reef effect matures. Degraer et al. (2020) indicate that the finfish community around artificial structures differs significantly from the surrounding natural habitat, as would be expected with the introduction of vertical hard structure available to biogenic (e.g., bivalve) habitat formation. While this is a subject of ongoing inquiry, this indicates that although full recovery of complex benthic habitats damaged by Project construction could take several years to potentially a decade or more, those impacts could be offset over a shorter period of time by beneficial reef effects to other species (see Section 3.6).

The RWF is in the vicinity of, and overlaps Cox Ledge, an area of complex benthic habitat that supports several commercially and recreationally important species. The observations at the BIWF and other European wind farms (Hutchison et al. 2020a; Methratta and Dardick 2019) indicate that commercially valuable species like black sea bass, Atlantic cod, and Atlantic pollock are likely to be attracted to the increased biological productivity these structures would create. While the available evidence to date suggests that the effects of long-term habitat alteration from wind farm development on finfish are generally beneficial at local and regional scales, considerable uncertainty remains about the potential for broader effects at population scales (Degraer et al. 2020). This could result in beneficial, neutral, or potentially negative effects. For example, increased feeding opportunities could translate to faster growth, increased fitness and survival, and increased reproductive success. Greater habitat productivity could also increase larval and juvenile survival within and around the affected habitats due to increased food availability and the protection offered by complex physical habitat. Wind farms could also create “ecological traps” that compel fish to remain in habitats that are unfavorable for spawning and larval survival (Degraer et al. 2020). The latter could also have negative consequences if vulnerable populations of fish are concentrated together with their predators and/or increased fishing effort. Habitat use of European wind farms by cod and Atlantic pollock has largely been seasonal (Reubens et al. 2013), indicating that negative effects on migratory and spawning behavior is unlikely, at least for these species.

A principal concern raised about offshore wind development is how the presence of numerous WTGs could affect the circulation and stratification patterns that form the environmental conditions relied upon by finfish and other marine organisms. BOEM recognizes that the potential for negative impacts—referred to here as hydrodynamic effects—are a focus of interest for cooperating agencies and stakeholders considering the RWF and other planned and potential future projects in the region. Specific concerns include the potential for disruption of the circulation and stratification patterns that maintain the Mid-Atlantic Bight cold pool, the alteration of stratification patterns that support the base of the marine food web, and the potential for changes in circulation patterns to negatively affect the reproductive success of numerous finfish species (Chen et al. 2016; Johnson et al. 2021). As mentioned previously, a growing body of research has demonstrated that offshore wind farms could have observable effects on oceanographic conditions up to tens of miles downfield from wind farm sites (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorrell et al. 2022; Floeter et al. 2022; Raghukumar et al. 2022), although the extent of these effects and resulting significance on biological processes are likely to vary considerably between different oceanographic environments (van Berkel et al. 2020). Van Berkel et al. (2020) and Schultze et al. (2020) note that environments characterized by strong seasonal stratification, such as the Mid-Atlantic Bight, are likely to be less sensitive to changes and disruptions to oceanographic processes from wind farm effects.

Offshore wind farms can influence hydrodynamic conditions through two mechanisms: turbulent effects on mixing and stratification patterns caused by current flow around structures in the water column, and changes in surface wave and current patterns caused by wind field effects (i.e., the extraction of wind energy from the atmosphere) (Johnson et al. 2021; van Berkel et al. 2020). Van Berkel et al. (2020) reviewed observed hydrodynamic effects from European offshore wind farms and characterized how these effects varied in significance in different oceanographic environments. Notably, van Berkel et al. (2020) observed that turbulent effects in environments having strong seasonal stratification were typically localized and less pronounced than those in other types of environments. Measurable effects on mixing and stratification patterns were typically limited to within 600 to 1,300 feet downcurrent of each monopile. In contrast, the combined wind field effects of a WTG array are typically more extensive, extending tens of miles downfield from the wind farm array (Johnson et al. 2021; van Berkel et al. 2020).

In addition to potential indirect effects to stratification, monopiles can also influence current speed and direction. Monopile wakes have been observed and modeled at the kilometer scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). The turbulence of tidal current wakes resulting from the presence of the monopile was found to decrease logarithmically moving away from the monopile (Li et al. 2014). Therefore, although impacts to current speed and direction decrease rapidly, there is evidence of hydrodynamic effects out to a kilometer away from a monopile.

The northern Mid-Atlantic Bight is characterized by strong seasonal stratification that contributes to the formation of a seasonal oceanographic feature known as the cold pool (Chen 2018; Lentz 2017). The cold pool is a mass of relatively cool water that forms at depth in the shallow waters of the OCS in the spring and is maintained through the summer by stratification. The cold pool is regional in scale and supports a diversity of marine finfish species that are usually found farther north but thrive in the cooler waters it provides (Chen 2018; Lentz 2017). Changes in the size and seasonal duration of the cold pool over the past 5 decades are associated with shifts in the fish community composition of the Mid-Atlantic Bight (Chen 2018; Saba and Munroe 2019). The RWF is located on the approximate northern boundary of the cold pool.

As mentioned previously, BOEM conducted a modeling study to predict how planned offshore wind development in the RI/MA and MA WEAs could affect hydrodynamic conditions northern Mid-Atlantic Bight (Johnson et al. 2021). This modeling study determined that the partial and full build-out scenarios considered would be unlikely to negatively affect, and may even strengthen, the stratification patterns that contribute to the formation and retention of the cold pool and food web productivity (Johnson et al. 2021). The BOEM modeling results determined that small but measurable changes in current speed, wave height, and sediment transport would occur across the northern Mid-Atlantic Bight. As stated, these effects are of potential concern because they could change how the planktonic eggs and larvae of many marine species are dispersed across the region. Changing larval dispersal pathways can disrupt connectivity between populations and the processes of larval settlement and recruitment (Sinclair 1988). Unfavorable changes can create a condition where a reproductively isolated population is negatively affected by a prolonged reduction in larval survival (Sinclair 1988). This could result in negative impacts on species like Atlantic cod that return to the same spawning habitats year after year and rely on relatively consistent oceanographic conditions to disperse planktonic eggs to areas favorable for larval and juvenile survival (Dean et al. 2022). However, insufficient information is available to determine the source populations of cod larvae and juveniles occurring in southern New England waters, and it is uncertain if the area is fully supported by self-recruitment (NEFMC 2022). Given this, hydrodynamic effects on these species could be more significant, but the available information does not suggest that such effects are likely.

The BOEM modeling study evaluated potential hydrodynamic effects of wind energy development on egg and larval dispersal for several commercially valuable finfish species. Johnson et al. (2021) found that the partial and full build-out of the RI/MA and MA WEAs would lead to localized changes in planktonic egg and larval dispersal patterns, with less extensive effects at lower levels of build-out. Although this study did not consider Atlantic cod, the findings for other finfish species are instructive. Johnson et al. (2021) determined that the larval dispersal patterns of each species, expressed as changes in predicted larval settlement density, would shift at scales of the order of miles to tens of miles. They concluded that these localized and effects are unlikely to be biologically significant at population levels for species like hake and scallops that spawn over broad areas across the region (Johnson et al. 2021). However, source and sink effects could occur for species that spawn in specific areas and rely on dispersal of larvae to favorable habitats. These effects could be positive, negative, or neutral, varying by species and depending on specific project effects.

Degraer et al. (2020) commented that the future decommissioning of offshore wind facilities could become controversial if they are shown to support high-value fish species. Although this potential is acknowledged, this EIS considers decommissioning as a component of the Proposed Action as required by BOEM for COP approval. Project decommissioning would remove the monopile foundations and scour and cable protection from the environment, reversing the artificial reef effect provided by these structures. Portions of the Project footprint, primarily along the RWEC corridor, would return to near pre-Project conditions, as influenced by ongoing environmental trends. As documented in Sections 3.6.2.3.2 and 3.6.2.4.2, benthic recovery is a complex process that involves both the reformation of benthic features, such as biogenic depressions and sand ripples, and recolonization of disturbed areas by habitat-forming invertebrates. Soft-bottom benthic habitats would likely recover to full habitat function within 18 to 30 months of disturbance while full recovery of habitat-forming organisms on complex benthic habitats could take several years to decades to fully recover (Auster and Langton 1999; Collie et al. 2005; Tamsett et al. 2010). A recent study (BOEM 2023e) found that after 6 years, complex habitats (i.e., epifuana/mussels/shell hash and sand/gravel/shell hash) within existing HAPCs on Georges Bank exposed to scallop dredging recovered to near 100% of epifaunal coverage and species diversity. Individual fish species (e.g., small fish sheltering in epibenthic structure on the monopiles) could be injured or killed during removal. The fish community that formed around the reef effect would be dispersed, and individuals that are unable to locate new suitable habitats might not survive. While the significance of these future effects for individual finfish species is difficult to predict, measurable long-term impacts on some species are almost certain to occur. Impacts of this duration and magnitude would constitute a moderate adverse effect on finfish.

In summary, the potential effects to finfish resulting from the presence of structures are likely to vary by species and could be beneficial, neutral, or negative. The available evidence suggests that some demersal fish species are likely to benefit from increased habitat structure and biological productivity while pelagic fishes may also benefit to a lesser extent. Thus, some finfish and EFH species could benefit from the effects of habitat conversion from Project construction and the presence of structures, whereas other species could be negatively impacted, depending on their habitat preferences. However, considerable uncertainty remains about the broader effects of this type of habitat alteration at population scales (Degraer et al. 2020). Wilber et al. (2022b) observed some shifts in the dietary composition of hake and winter flounder that associate with BIWF in comparison to those in reference areas, but there were no apparent negative effects on fish condition or other trophic metrics. However, BIWF is small in scale compared to the RWF Project. Broader-scale reef effects from larger projects could noticeably influence food web productivity and predator-prey relationships that could in turn lead to beneficial, neutral, or negative effects on finfish, varying by species based on habitat preferences and response of prey organisms to the presence of structures. These effects could become more significant when combined with those from other planned offshore wind energy projects in the future. On this basis, habitat alteration on finfish resulting from the Proposed Action are expected to be long term in duration and **moderate** beneficial to **moderate** adverse in significance, varying by species. The hydrodynamic impacts of the Proposed Action could affect the productivity of finfish species that rely on planktonic dispersal of eggs and larvae. Localized shifts in larval settlement density are likely to occur; however, it is not clear that those shifts would measurably alter larval survival sufficiently to have a measurable effect at the population level. Changes in larval settlement patterns in the absence of population-level effects would constitute a **minor** to **moderate** impact on this resource, potentially positive or negative and varying by species.

<u>Sediment deposition and burial</u>: Cable protection maintenance would produce similar effects on finfish as those described for Project construction, although reduced in extent and spread out over time. These effects would range from short-term behavioral disturbance and displacement of demersal and pelagic fish accustomed to naturally high rates of sediment deposition to injury and mortality of benthic eggs and larvae subject to burial effects greater than 0.4 inch (10 mm). The IAC, OSS-link cable, and RWEC would be removed from the seafloor during Project decommissioning. Removal of cable protection and extraction of the cable from the seafloor would disturb sediments, releasing TSS into the water column.

The resulting effects from O&M and decommissioning would be similar in nature but lesser in magnitude than those resulting from Project construction and would therefore be **minor** adverse.

3.13.2.4.3 Cumulative Impacts

Offshore Activities and Facilities

Accidental releases and discharges: The Proposed Action in combination with other past, present, and reasonably foreseeable future activities could result in an increase in accidental releases of petroleum products and other toxic substances that could adversely affect finfish. As discussed in Section 3.21.2.2.3, BOEM estimates that the Project when combined with other future offshore wind projects would result in approximately 34 million gallons of coolants, fuel, oils, and lubricants cumulatively stored within WTGs and OSSs within the finfish GAA. All vessels associated with offshore wind projects would comply with USCG requirements for the prevention and control of oil and fuel spills. Additionally, training and awareness of EPMs (see Table F-1 in Appendix F) proposed for waste management and marine debris would be required of RWF Project personnel. Such releases would occur infrequently at discrete locations and vary widely in space and time. For this reason, the Proposed Action when combined with other past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts on finfish ranging from short term to long term in duration.

Anchoring and new cable emplacement/maintenance: The Proposed Action would result in localized short-term minor adverse impacts to finfish through an estimated 7,150 acres of seafloor disturbance in the GAA. These actions would increase suspended sediment and potentially disturb, displace, or injure finfish, resulting in noticeable minor to moderate adverse impacts to finfish through an estimated 3,204 acres of general vessel anchoring and mooring-related disturbance and 4,009 acres of cabling-related seafloor disturbance. BOEM estimates a cumulative total of 11,631 acres of anchoring and mooring-related disturbance and 105,390 acres of cabling-related disturbance for the Proposed Action plus all other future offshore wind projects within the finfish GAA. While the suspended sediment effects from this seafloor disturbance are not known, they are expected to be similar in magnitude and extent to those described for the Proposed Action. More extensive suspended sediment and deposition effects could occur in areas where mud and silts are more prevalent in seafloor sediments, although species inhabiting soft sediment habitats are generally adapted to episodic and localized increases in turbidity (such as during storms). When combined with other past, present, and reasonably foreseeable actions, the Proposed Action would result in minor adverse impacts. Those impacts would combine with stressors from other ongoing activities and environmental trends, including commercial and recreational fishing, climate change, nearshore habitat degradation, and nonnative species invasions, which are likely to have minor to moderate adverse effects on finfish. Therefore, the Proposed Action when combined with past, present, and reasonably foreseeable projects and other stressors would result in **minor** to **moderate** adverse cumulative impacts to finfish.

Bycatch: The FRMP (Revolution Wind and Inspire Environmental 2023) will be implemented under the Proposed Action (see EPM Ben-17 in Appendix F, Table F-1). The FRMP employs a variety of preconstruction and postconstruction survey methods to evaluate the effect of RWF construction and operations on benthic habitat structure and commercially and recreationally valuable finfish species. The FRMP includes a combination of methods to capture finfish for direct study. These methods described in Table 3.13-8 could directly or indirectly impact finfish during the specified study periods.

Table 3.13-8. Survey Methods

Method	Description
Ventless trap surveys	Used to evaluate changes in the distribution and abundance of lobster and Jonah crab in the RWF and adjacent reference areas, and Jonah crab, lobster, whelk (Buccinidae), and finfish along the RWEC corridor and adjacent reference areas; these areas would be surveyed 12 times per month for 7 months each for 2 years prior to and at least 2 years following completion of Project construction (4 years total)
Otter trawl surveys	Used to assess abundance and distribution of target fish and invertebrate species within the RWF; trawls could impact a variety of finfish species as target or bycatch four times per year for 2 years prior to and at least 2 years following completion of Project construction
Acoustic telemetry	Revolution Wind will provide funding, equipment, and support to expand ongoing acoustic telemetry survey efforts in and near the RI/MA WEA. Partnering entities include the Massachusetts Division of Marine Fisheries, University of Massachusetts Dartmouth School for Marine Science and Technology, NOAA, Woods Hole Oceanographic Institution, the Nature Conservancy, INSPIRE Environmental, and the Anderson Cabot Center for Ocean Life at the New England Aquarium. These efforts are monitoring the presence and persistence of Atlantic cod, highly migratory species, and other fish species of interest within and in proximity to MA/RI WEA. Revolution Wind has funded the purchase of six VR2W telemetry receivers to complement the existing receiver array, funded the deployment of an additional 150 acoustic transmitters for highly migratory species, and will fund an additional 5 years of data collection for these ongoing survey efforts. Revolution Wind will tag up to 100 Atlantic cod with acoustic transmitters as part of the FRMP to support the ongoing, BOEM-funded Atlantic cod spawning study in southern New England as well.

These surveys involve similar methods to and would complement other survey efforts conducted by various state, federal, and university entities supporting regional fisheries research and management.

The surveys would target specific invertebrate species using methods and equipment commonly employed in regional commercial fisheries. Finfish could be impacted if captured as bycatch or by being injured or killed when survey equipment contacts the seafloor or during acoustic transmitter tagging of Atlantic cod. Non-target organisms would be returned to the environment where practicable, but some of these organisms would likely not survive. While the FRMP would result in unavoidable impacts to individual finfish, the extent of habitat disturbance and the number of organisms affected would be small in comparison to the baseline level of impacts from commercial fisheries and would not measurably impact the viability of any species at the population level. Randomized sampling distribution means that repeated disturbance of the same habitat is unlikely. As such, all habitat impacts from FRMP implementation would be short term in duration. The intensity and duration of impacts anticipated from FRMP implementation would constitute a **minor** adverse cumulative effect on finfish.

Climate change: The types of impacts from global climate change described for the No Action Alternative would occur under the Proposed Action, but the Proposed Action could contribute to a long-term net decrease in GHG emissions. This difference may not be measurable but would be expected to help reduce climate change impacts over the life of the Project. When combined with other past, present, and reasonably foreseeable actions, the Proposed Action would have a noticeable effect on climate change, but climate change would continue to generate **moderate** adverse cumulative impacts on finfish.

EMF: The Proposed Action is not expected to produce significant EMF effects, as discussed in Section 3.13.2.2.2. BOEM anticipates that future offshore wind energy projects in the GAA would use HVAC transmission and apply similar design measures to avoid and minimize EMF effects on the environment. While uncertainties remain, future actions that produce EMF effects on the order of those generated by the Proposed Action are unlikely to have significant cumulative effects on finfish. Additive effects from multiple cables are likely to be limited to specific areas where cable routes cross. The Project's network of submarine cable (i.e., RWEC, IAC, and OSS-link cable) and cables from other planned and potential future projects could cross existing submarine assets, resulting in cables on the seafloor surface with secondary protection. EMF levels sufficient to cause limited behavioral effects on finfish could occur in highly localized areas. These effects would be unlikely to significantly alter finfish behavior in ways that measurably affect any species at the population level. Cumulative EMF impacts resulting from the Proposed Action in combination with past, present, and reasonably foreseeable activities would therefore result in **minor** adverse effects on finfish from exposure to detectable levels of EMF in limited areas.

Noise: The Proposed Action would result in noticeable short-term negligible to moderate adverse impacts to finfish through the generation of underwater noise during construction and installation. The Proposed Action would produce injury or behavioral-level noise effects on fish extending up to 38,625 feet from construction and installation–related impact pile-driving activities. For the protection of finfish, TOY restrictions would be established through the permitting process. Revolution Wind would adhere to the TOY restrictions imposed on the various elements of the Project through the permitting process (see Appendix F, Table F-1). These effects could be additive to areas ensonified by other temporally or spatially overlapping future activities. BOEM estimates that underwater noise from the construction of other future offshore wind facilities would result in short-term injury or behavioral effects on finfish. Vessel noise from construction and installation, as well as O&M activities, could cause startle and avoidance responses in fish but would not cause injury. Therefore, the cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would be **negligible** to **moderate** adverse.

The most significant impact for individual Atlantic sturgeon would be underwater noise from pile driving; however, Project effects to individual Atlantic sturgeon would be limited to short-term minor adverse behavioral effects and disturbance that would be undetectable at population levels. For this reason, Proposed Action cumulative impacts when combined with past, present, and reasonably foreseeable future activities would also be **minor** adverse and not anticipated to result in adverse population-level consequences.

The Proposed Action and other planned and future offshore wind energy projects would include fisheries and benthic habitat monitoring plans to gather information about the effects of wind energy development on finfish and other marine resources. These activities would increase knowledge about finfish use of the Mid-Atlantic OCS and the structure and composition of their habitats. This information could lead to improved management of finfish species and key habitats. This would constitute a **minor** beneficial cumulative effect on finfish resources.

Presence of structures: The Proposed Action would result in long-term alteration of water column and seafloor habitats, resulting in diverse effects on finfish. The monopile foundations and other hard surfaces installed as part of the Proposed Action would create an artificial reef effect. The new offshore structures would also cause localized hydrodynamic effects that would influence primary and secondary productivity within and around this artificial reef. The reef effect would alter biological community structure, producing an array of effects on finfish, including several EFH species.

BOEM estimates the Proposed Action and other planned future projects would result in the development of 3,190 WTG and OSS foundations in the GAA for finfish that could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential significance of broader cumulative effects on finfish resulting from the formation of multiple large-scale artificial reefs in the region and the biological hotspots they support.

As mentioned previously, BOEM conducted a modeling study to predict how planned offshore wind development in the RI/MA and MA WEAs could affect hydrodynamic conditions in the northern Mid-Atlantic Bight. BOEM determined that small but measurable changes in current speed, wave height, and sediment transport in the northern Mid-Atlantic Bight would occur. In addition, small changes in stratification could occur, leading to prolonged retention of cold water near the seafloor within the WEAs during spring and summer. However, these localized and small effects are unlikely to be biologically significant at population levels (Johnson et al. 2021).

While modeled hydrodynamic effects from even the fully developed scenario considered by Johnson et al. (2021) are expected to be small in themselves, it is not clear how these effects would interact with the additional impact of the placement of artificial structures on finfish populations and communities. The expected shifts to fish community structure induced by the presence of a large number of artificial structures are likely to confound the projected hydrodynamic impacts. Collectively, these two modes of offshore wind development are likely to result in permanent and potentially significant impacts on larger scales. Collectively, cumulative impacts from the combined reef and hydrodynamic effects of multiple offshore wind energy projects on finfish could be positive or negative, varying by species, and would likely range from **moderate** adverse to **moderate** beneficial in significance, varying by species.

<u>Sediment deposition and burial</u>: The Proposed Action in combination with future offshore wind projects would generate similar sediment deposition and burial effects to those described in Section 3.13.2.2.1. Impacts would be short term and would have limited significant burial effects relative to the amount of habitat available; therefore, burial effects on benthic eggs and larvae would be minor adverse. Cumulative impacts would be more extensive and distributed across the GAA. As stated, these effects would be short term in duration and would range in severity from negligible to minor adverse at any given location. Cumulative short-term impacts from all planned and future projects are not likely to have measurable population-level effects on any finfish species; therefore, cumulative effects from sediment deposition and burial would be **minor** adverse.

3.13.2.4.4 Conclusions

Project construction and installation, O&M, and decommissioning would impact finfish by causing short-term habitat disturbance; permanent habitat conversion; and behavioral changes, injury, and mortality of finfish. Effects to finfish resulting from the Proposed Action would vary by IPF and would vary depending on finfish exposure to those effects, individual habitat requirements, species, and life stage–specific sensitivity to Project-related impacts. 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 oriented fish species and life stages such as skates and flatfish as well as the eggs and larval stages of finfish. The continued presence of foundations could also affect pelagic habitat by leaving permanent vertical habitat that would host an altered community of benthic and associated demersal and pelagic organisms. The altered finfish community utilizing these artificial reef structures could persist beyond removal of the majority of the structures.

BOEM anticipates the impacts resulting from the Proposed Action alone would range from **negligible** to **moderate** adverse, including the presence of structures, which could result in **moderate** beneficial impacts for some finfish. Overall, the impacts of Proposed Action alone on finfish would likely be **moderate** adverse. Although some of the proposed activities and/or IPFs analyzed could overlap, BOEM does not anticipate that these combined effects would alter the overall significance determination because they would not alter impacts on any species to such a degree that measurable population-level effects would occur.

The Proposed Action would be more likely to impact fish species having demersal- or benthic-oriented life stages than those that are more pelagic (i.e., water column) oriented, since the majority of Project activities impact the seafloor. However, pelagic species and life stages could be impacted by elevated suspended sediments, associated primarily with jet and mechanical plow operation. Entrainment in plow intakes would result in short-term impacts on pelagic eggs and larvae. Pile-driving noise, although short-term, could impact all benthic and pelagic life stages. The operational phase of the Proposed Action alone could lead to uncertain but possibly beneficial effects on many finfish species through reef effects. The adverse impacts associated with the construction and installation, O&M, and decommissioning of the Proposed Action alone are likely to be limited in temporal scope and/or small in proportion to the overall habitat available regionally.

In the context of other reasonably foreseeable environmental trends and planned actions, the impacts of individual IPFs under the Proposed Action would range from **negligible** to **moderate** adverse and **moderate** beneficial for some finfish. Applying the impact-level criteria in Section 3.3, BOEM anticipates that the overall impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable offshore wind development activities and the effects of other ongoing activities and environmental trends would result in **moderate** adverse impacts on finfish in the GAA 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. The main drivers for this impact rating are injury and mortality from construction-related noise impacts, long-term habitat changes resulting from the presence of structures, direct mortality and habitat disturbance associated with ongoing commercial and recreational fisheries, and climate change.

Revolution Wind has committed to implement EPMs to reduce potential impacts on benthic finfish resources (see Table F-1 in Appendix F).

3.13.2.5 Alternative B: Impacts of the Proposed Action on Essential Fish Habitat

3.13.2.5.1 Construction and Installation

Offshore Activities and Facilities

BOEM (2023c, 2023d) has developed a detailed assessment of the potential effects on EFH resulting from construction of the Proposed Action. The following sections describe these impact mechanisms in detail and provide examples of their potential effects on representative finfish and EFH species and their habitats. In general, effects on EFH resulting from the construction-related impact mechanisms would be similar in magnitude and extent to the effects on finfish described in Section 3.13.2, as well as the impacts to benthic habitat and invertebrates, as discussed in Section 3.6.

Accidental releases and discharges: Project compliance with discharge or disposal of solid debris into offshore waters would be as described in Section 3.13.2.2.1. Given these restrictions, the risk to EFH species and habitats from trash and debris from the Proposed Action is **negligible** adverse.

The Project would follow strict oil spill prevention and response procedures during all Project phases, effectively avoiding the risk of large-scale, environmentally damaging spills under reasonably foreseeable circumstances. In the unlikely event that a vessel collision or allision with a WTG or OSS foundation resulted in a high-volume spill, **minor** to **moderate** adverse effects to EFH species and their habitats could result.

Anchoring and new cable emplacement/maintenance: The acres of construction-related seafloor disturbance are summarized by benthic habitat type in Section 3.6.2.4.1 and Table 3.6-4 and above in Section 3.13.2.4.1. As shown, seafloor disturbance from jack-up vessels and general vessel anchoring could impact up to 3,247 acres. Seafloor disturbance from various overlapping cable installation activities, including boulder relocation, jet plow trenching for cable installation, and placement of cable protection, could impact up to 2,043 acres distributed throughout the RWF and RWEC maximum work areas.

The total acreage and distribution of anchoring impacts cannot be predicted with certainty because anchoring requirements and vessel positioning are affected by wind and current conditions in real time. The vessel anchoring plan developed by the applicant will be used to identify and avoid impacts to large-grained complex and complex benthic habitats to the greatest extent practicable. Impacts on bedforms in soft-bottom benthic habitat are expected to recover within 18 to 30 months following initial disturbance as a result of natural sediment transport processes (Daylander et al. 2012) and recolonization by habitat-forming organisms from adjacent habitats. This estimate is based on observed recovery rates from fishing-related disturbance (Grabowski et al. 2014), on cable installation impacts at the nearby BIWF (HDR 2020), and on similar seafloor disturbance impacts observed in other regions (de Marignac et al. 2008). Research obtained by BOEM (2023e) suggests that full recovery of habitat function is likely to occur within a decade of disturbance. The study in question compared the community composition and abundance of habitat-forming organisms in heavily fished areas on Georges Bank to reference sites. The findings of this long-term study demonstrated that epifaunal species damaged by repeated exposure to scallop dredging were able to recover to levels that were statistically indistinguishable from unfished reference sites within 6 years. Given the proximity of this study to the Lease Area and the similarity of disturbance, these findings suggest a similar rate of recovery is likely for Project-related construction impacts.

The estimated area of short-term disturbance from anchoring would depend on the vessel and activity. The derrick barge crane vessel used during monopile installation could disturb 9.1 acres of seafloor per monopile, due to placement of its 8-point 12-ton delta flipper anchor twice at each foundation. Vessels that use anchors (rather than spud cans) to hold position generally have a greater potential to disturb the seafloor and result in crushing or burial impacts. Aside from monopile installation activities, vessels within the RWF work area would primarily use dynamic positioning systems to hold position and would not have any crushing or burial impacts.

Seafloor preparation, cable trenching, vessel anchoring, and short-term seafloor disturbance at the sea-to-shore transition site would also directly disturb soft-bottom benthic habitat. Seafloor preparation, cable trenching, and sea-to-shore transition construction would impact up to 1,360 acres of habitat within the installation corridors for the RWF and RWEC (see Table 3.6-4). Approximately 4.8% and 22.7% of these impacts would occur in large-grained complex and complex benthic habitats, respectively, and 72.5% would occur in soft-bottom habitats (see Table 3.6-4).

Impacts to large-grained complex and complex benthic habitat from vessel anchoring, cable installation and cable protection, and seafloor preparation for foundation installation could impact managed finfish that use these habitats (e.g., monkfish) and may indirectly disturb Atlantic cod spawning. Atlantic cod spawning could be disturbed if anchoring and cable emplacement activities (e.g., grapnel runs and jet plowing) are occurring in proximity. Figure 3.13-4 shows the locations of cod observation data in relation to the Proposed Action (observations primarily observed in Zone RWC 1). Micrositing would be used during construction to minimize impacts on large-grained complex and complex benthic habitats to the greatest extent practicable. Additional measures designed to reduce impacts to complex habitats (e.g., using a boulder grab and a work-class remotely operated vehicle boulder skid for most of the boulder relocations) would minimize impacts and modifications to complex habitats that may support biological functions like spawning.

EFH within these construction footprints would be directly exposed to disturbance. On balance, these impacts would constitute short-term, long-term, and permanent adverse impacts on EFH. Long-term to permanent impacts would primarily involve the redistribution of existing complex and soft-bottomed habitats and the introduction of new hard surfaces. The affected habitats would recover to functional condition over time, such that long-term to permanent effects on the ability to support EFH would be minimal. Therefore, these impacts would be **minor to moderate** adverse.

<u>Noise:</u> The construction and installation of the RWF involves activities that would generate underwater noise exceeding established thresholds for mortality and permanent or short-term injury, TTS, and behavioral effects. Underwater noise would render the affected habitats unsuitable for EFH species over the short term and could have short-term impacts on prey availability for EFH species. The extent, duration, and severity of noise effects on EFH would vary depending on the noise source and the sensitivity of the affected EFH species and their prey to noise impacts during their life cycle. The underwater noise effects would result from such Project activities as preconstruction HRG surveys, vessel and cable installation activity, impact and vibratory pile driving, and UXO detonation and would be the same or similar as those described above for finfish and in Section 3.6 for benthic habitat and would likely range from **minor** to **moderate** adverse.

<u>Presence of structures:</u> The installation of 102 monopile foundations with associated scour protection would result in the same direct disturbance to EFH species and their habitats as described previously for finfish. Seafloor preparation for foundation installation would cover approximately 731 acres, approximately 19% in large-grained complex benthic habitat, 30% in complex habitat, and 51% in soft-bottom benthic habitat. EFH within the benthic disturbance footprints for foundation installation could be

exposed to crushing and burial effects similar to those described previously for anchoring and new cable emplacement/maintenance.

While placement of the monopile foundations and scour protection are also elements of Project construction and installation, these features would remain in place throughout the operational life of the Project and would have long-term effects on EFH species and habitats. These long-term effects are therefore considered in Section 3.13.2.3.2.

<u>Sediment deposition and burial:</u> Sediment deposition and burial effects on EFH species would be similar to those described previously for finfish. The Project would result in short-term, elevated levels of suspended sediment near major bed-disturbing activities like cable installation. Anticipated water column sediment concentrations and burial depths resulting from this impact mechanism are shown in Table 3.6-8. TSS concentrations of the magnitude and duration anticipated are below levels associated with measurable adverse effects on finfish (Wilber and Clarke 2001; Yang et al. 2017) and would therefore be negligible adverse to EFH species. While some adverse effects would undoubtedly occur, the extent of deposition and burial impacts is small relative to the amount of EFH habitat available, and the duration of those impacts would be short term (hours to days). Given the short-term nature of the impact and the limited extent of significant burial effects relative to the amount of habitat available, sediment deposition and burial effects on EFH habitat would be short term and expected to recover without remedial or mitigating action and therefore would be **minor** adverse.

3.13.2.5.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

BOEM (2023c, 2023d) has developed a detailed assessment of the potential effects on EFH resulting from the O&M of the Proposed Action. The following sections describe these impact mechanisms in detail and provide examples of their potential effects on representative finfish and EFH species and their habitats.

<u>Accidental releases and discharges:</u> The prohibitions on releases of trash and debris and accidental spill avoidance and minimization measures described in Section 3.6.2.2.1 for Project construction would continue to apply throughout the operational life of the Project. These restrictions and measures would effectively avoid adverse effects from Project-related trash and debris and accidental spills during routine O&M activities. Therefore, the effects of this impact mechanism on EFH species and their habitats would be **negligible** adverse.

<u>Anchoring and new cable emplacement/maintenance:</u> Impacts to EFH species and habitats from the replacement of cable protection would be the same or similar to those described previously for finfish and habitat. These would include direct disturbance of the seafloor, suspended sediment deposition in the surrounding area, and injury and displacement of finfish using these habitats. It is anticipated that these activities would result in short-term **minor** adverse impacts to EFH species and their habitats.

<u>EMF:</u> The EMF and associated substrate heating effects anticipated to result from operations of the RWEC and IAC are summarized in Table 3.6-10 in Section 3.6.2.3.2. This table summarizes potential EMF and substrate heating exposure for benthic invertebrates. Those findings are also applicable to benthic-associated EFH invertebrates.

The effects of EMF and associated substrate heating on EFH species and habitats would be the same as those described previously for finfish in Section 3.13.2.2.2, wherein findings indicate that long-term EMF effects on EFH would likely be **minor** adverse along most of the lengths of the IAC, OSS-link cable, and RWEC.

Noise: Operational noise is described in Section 3.13.2.2.2. Postconstruction HRG surveys could be conducted each year for the first 4 years of Project operations. This equates to approximately 25 days of HRG survey activity per year. The related effects on finfish would be similar in nature to those described for construction-related HRG surveys in Section 3.13.2.2.1 but reduced in extent and duration. The limited behavioral responses to HRG survey equipment and vessels would be similar to those described above for general O&M vessel noise.

While HRG survey noise would exceed the behavioral effects threshold over a larger cumulative area (3,352,996 acres), the continuously moving HRG vessels would distribute those impacts over approximately 10,759 linear miles and 248 days of survey effort. The instantaneous behavioral effects exposure area around the HRG equipment would be considerably smaller, approximately 477 acres. As described for construction and installation noise in Section 3.13.2.4.1, underwater sound from vessels can cause avoidance behavior in sensitive fish species like Atlantic herring and Atlantic cod and may affect behavior of other species as well (Handegard et al. 2003; Vabø et al. 2002). However, behavioral disturbance may not necessarily translate to significant adverse effects on activities like spawning. For example, McQueen et al. (2022) observed that exposure to seismic air gun noise did not cause displacement of Atlantic cod from their spawning grounds. This suggests that exposure to underwater noise from postconstruction HRG surveys and O&M vessels would not necessarily lead to significant adverse behavioral effects. Such behavioral responses are likely to vary due to differences in sensitivity between species and other environmental factors (McQueen et al. 2022).

Operational noise impacts on hearing specialist species, like Atlantic cod, haddock, Atlantic pollock, and hake, could be more significant, but whether or not auditory masking occurs and has an effect on survival and reproduction in the wild around operational offshore wind farms is not known (Mooney et al. 2020). Studies conducted on captive cod (adults and larvae) that have found impacts to reproduction and survival (Sierra-Flores et al. 2015; Nedelec et al. 2015), although instructive, do not mimic natural conditions, and the results cannot be assumed to occur in wild animals with certainty. In Europe, some species, such as Atlantic cod, have shown no response in relation to sound levels and have shown increases in abundance close to wind turbines (Bergstrom et al. 2013). Based on the evidence presented, BOEM anticipates that operational noise from WTGs, and noise from postconstruction HRG surveys and O&M operations, would result in **negligible** to **minor** adverse effects on EFH.

Presence of structures: The artificial reef effect, as well as hydrodynamic effects, is discussed in Section 3.13.2.2.2. Foundations and scour protection would result in permanent effects on benthic and pelagic habitats on the Mid-Atlantic OCS. The benthic habitat conversion impacts are summarized by category in Table 3.13-9.

Table 3.13-9. Long-Term Habitat Conversion Impact Area by Project Feature and Habitat Complexity Category

Project Feature	Element	Maximum Habitat Conversion Footprint (acres)*	Percent of Disturbance in Large-Grained Complex Habitat	Percent of Disturbance in Complex Habitat	Percent of Disturbance in Soft Bottom Habitat	Water Column (m^3)
WTG and OSS foundations	Seafloor preparation	583	19.0%)	29.7%	51.3%	N/A
	Scour protection±	62.3	5.6%	30.8%	62.6%	N/A
	Monopiles	2.9	6.1%	29.9%	64.0%	107,499‡
IAC, OSS-link, RWEC	Boulder relocation	2,314	6.4%)	22.6%	71.0%)	N/A
	Cable protection†	116.2	6.4%	22.7%	70.9%	N/A

‡ Based on WTG and monopile foundation diameter assuming an average depth of 35 meters.

± Acreage estimates include 0.07 acre per foundation of additional habitat conversion effects from cable protection system features extending beyond the scour protection footprint.

† Precise cable protection acreages required within each habitat zone are not currently known. Values are estimated based on total cable length within each zone, and the estimated percentage of cable length requiring protection as presented in the COP (VHB 2023).

These benthic habitat impacts would be permanent. Similarly, impacts to pelagic habitat would result from the presence of the monopile foundations for the WTGs and OSSs. The installation of one-hundred-two 39-foot-diameter (12-m-diameter) monopile foundations would introduce approximately 12,000 to 16,000 m^2 of new hard surfaces to the water column, respectively, extending from the seafloor to the water surface. These vertical structures would alter pelagic habitats used by EFH species and their prey and forage. Over time these new hard surfaces will become colonized by sessile organisms, creating complex habitats that effectively serve as artificial reefs. The artificial reef effect created by offshore structures like WTGs is well documented and can have an attractive effect on many marine species (Langhamer 2012; Peterson and Malm 2006; Reubens et al. 2013; Wilhelmsson et al. 2006). This can lead to localized increases in fish abundance and changes in community structure. The net effect of WTGs on pelagic EFH species and habitat is likely to be neutral to beneficial depending on species-specific responses, with the recognition that beneficial effects could be negated should these structures inadvertently promote the establishment of invasive species on the Mid-Atlantic OCS.

In addition to reef effects, the hydrodynamic effects of the RWF could have localized effects on food web productivity and on the dispersal patterns of EFH species having pelagic eggs and larvae. As discussed in Section 3.13.2.2.2, reef and hydrodynamic effects on EFH species could be positive, negative, or neutral depending on a variety of factors. In theory, long-term hydrodynamic and reef effects could influence future changes to existing EFH and HAPC designations. For example, changes in egg and larval dispersal patterns caused by the hydrodynamic effects of the Proposed Action could affect the abundance and productivity of certain EFH species and change the importance of some habitats. Hydrodynamic effects could also lead to shifts in egg and larval dispersal patterns that change the importance of existing habitats. This could in turn lead to changes in HAPC designations to include new areas that are shown to provide productive habitat.

With regard to reef effects, the presence of offshore wind structures and the complex habitats they support are expected to affect EFH in ways that may be difficult to predict. The complex structure and biological productivity supported by reef effects been shown to attract and support increased abundance of many finfish and invertebrates, including EFH species, as well as their predators (see Sections 3.6.2.2.2 and 3.13.2.3.2). These changes are likely to lead to changes in food web dynamics. While localized effects are possible, ecosystem modeling studies of a European wind farm showed little difference in key food web indicators before and after construction and installation (Raoux et al. 2017). Even though the biomass of certain taxa increased in proximity to the wind farm, trophic group structure was functionally similar between the before and after scenarios. Thus, regional-scale changes in food web dynamics are not anticipated.

On balance, the presence of structures is likely to result in a range of effects on EFH species and habitats. Those effects could be **minor** to **moderate** in significance and adverse, beneficial, or neutral, and would vary by species depending on individual habitat requirements.

Sediment deposition and burial: Cable protection maintenance would produce similar effects on EFH species as those described for Project construction and installation, although reduced in extent and spread out over time. The resulting effects from O&M and decommissioning would be similar in nature but lesser in magnitude than those resulting from Project construction and would therefore be **minor** adverse.

3.13.2.5.3 Cumulative Impacts

Offshore Activities and Facilities

Accidental releases and discharges: Section 13.2.2.3 estimates potential coolants, fuel, oils, and lubricants cumulatively stored within WTGs and OSSs within the EFH GAA and discusses measures that would be implemented to prevent and control oil and fuel spills. Based on that analysis, the Proposed Action when combined with other past, present, and reasonably foreseeable projects would result in **negligible** to **minor** adverse cumulative impacts on EFH ranging from short term to long term in duration.

Anchoring and new cable emplacement/maintenance: Section 13.2.2.3 estimates Proposed Action and cumulative cabling-related disturbance within the EFH GAA. The Proposed Action would increase suspended sediment and potentially disturb, displace, or injure individual EFH species, resulting in localized **minor** to **moderate** adverse impacts. Cumulatively, while the suspended sediment effects from this seafloor disturbance are not known, they are expected to be similar in magnitude and extent to those described for the Proposed Action. More extensive suspended sediment and deposition effects could occur in areas where mud and silts are more prevalent in seafloor sediments. Some projects could also include dredging for O&M facility development or related port improvements, which could contribute to suspended sediment and deposition effects. When combined with other past, present, and reasonably foreseeable actions the Proposed Action would result in **moderate** adverse cumulative impacts.

Bycatch: EFH impacts due to bycatch would be as discussed in Section 3.13.2.2.3. The intensity and duration of impacts anticipated from FRMP implementation would constitute a **minor** adverse cumulative effect on EFH. These impacts would be offset by an improved understanding of the effects of offshore wind development on regional fish species and their habitats. This could in turn contribute to improved management of EFH species and their habitats.

Climate change: EFH impacts due to climate change would be as discussed in Section 3.13.2.2.3. Climate change would result in **moderate** adverse cumulative impacts even when the offsetting effects of the Proposed Action are combined with those from other past, present, and reasonably foreseeable projects.

EMF: The Proposed Action is not expected to produce significant EMF effects, as discussed in 3.13.2.2.3. Cumulative EMF impacts resulting from the Proposed Action in combination with past, present, and reasonably foreseeable activities would be **minor** adverse if HVAC is used, or **moderate** adverse if HVDC is used.

Noise: The Proposed Action would result in noticeable short-term **negligible** to **moderate** adverse impacts to EFH species and their habitat through the generation of underwater noise during construction and installation, as described in Section 3.13.2.2.3. The Proposed Action would produce injury or behavioral-level noise effects on fish extending up to 39,380 feet from construction and installation–related impact pile-driving activities. Periodic noise from O&M vessels and continuous or near-continuous WTG operational noise exceeding behavioral effects thresholds for EFH species would occur within a few hundred feet of each source (see Section 3.13.2.5.2). These effects would occur over the life of the Project through decommissioning. These localized and short-term to permanent cumulative impacts from the Proposed Action would combine with similar localized impacts from other past, present, and reasonably foreseeable activities, resulting in **negligible** to **minor** adverse effects on EFH.

Presence of structures: Cumulative to EFH, expressed in terms of effects on benthic habitat, invertebrates, and finfish and their habitats are described in Sections 3.6.2.2.3, 3.6.2.3.3, and 3.13.2.2.3, respectively.

BOEM estimates the Proposed Action and other planned future projects would result in the development of 3,190 WTG and OSS foundations in the EFH GAA. Depending on how these are located and distributed, the development of multiple large-scale projects could have broader scale cumulative effects on biological communities than the Proposed Action considered in isolation (Degraer et al. 2020; van Berkel et al. 2020). More research is needed to determine the likelihood and potential significance of broader cumulative effects on EFH species and habitat. Collectively, cumulative impacts from the combined reef and hydrodynamic effects of multiple offshore wind energy projects on EFH could be positive or negative, varying by species, and would likely range from **moderate** adverse to **moderate** beneficial in significance, varying by species.

Collectively, the Proposed Action when combined with past, present, and reasonably foreseeable projects would result in **negligible** to **minor** beneficial cumulative effects on EFH species from removal of derelict fishing gear and marine debris.

Sediment deposition and burial: The Proposed Action in combination with future offshore wind projects would generate similar sediment deposition and burial effects to those described in Section 3.13.2.2.3. As stated, these effects would be short term in duration. Cumulative short-term impacts from all planned and future projects are not likely to have measurable population-level effects on any EFH species; therefore, cumulative effects from sediment deposition and burial would be **minor** adverse.

3.13.2.5.4 Conclusions

Over 40 species of finfish with designated EFH and HAPC occur within the RWF Lease Area and the RWEC Project easement. The Proposed Action includes construction and installation, O&M, and decommissioning of the Project components. Project decommissioning would occur at the end of the 35-year operating period of the Project and would be subject to a separate EFH consultation at that time.

Project construction and installation would result in short-term adverse effects on the environment that could affect habitat suitability for managed species. Short-term adverse effects include construction and installation–related underwater noise impacts; crushing, burial, and entrainment effects; and disturbance of bottom substrates resulting in increased turbidity and sedimentation. These effects would occur intermittently at varying locations in the RWF Lease Area and the RWEC project easement over the duration of Project construction and installation but are not expected to cause permanent effects on EFH habitat quality. Depending on the nature, extent, and severity of each effect, this may temporarily reduce the suitability of EFH habitat for managed species, which would result in short-term adverse effects on EFH habitat for those species. For example, the Proposed Action would result in the full build-out of the entire Lease Area, including areas of large-grained complex and complex habitats that recent data indicate support spawning Atlantic cod (Van Hoeck et al. 2023). This would result in underwater noise from pile driving and disturbances from anchoring, cable emplacement, and seafloor preparation for foundations that could temporarily render the affected habitats unsuitable as EFH for multiple life stages of Atlantic cod (e.g., spawning adult cod present in Zones RWF 1 and 2). However, EPMs committed to by Revolution Wind (see Table F-1, Appendix F), including ramp-up/soft starts and TOY restrictions for pile-driving activity (January through April), would reduce the magnitude and temporal extent of impacts to Atlantic cod spawning, which existing data indicate is occurring both within (primarily in Zone RWF 1) and outside the Lease Area between October and March (DeCelles et al. 2017; Inspire Environmental 2019a, 2020; Van Hoeck et al. 2023). In addition, Revolution Wind would coordinate with RIDEM and NOAA NMFS regarding TOY restrictions through the permitting process and would adhere to requirements imposed by these agencies (e.g., TOY restrictions to avoid and/or minimize impacts to winter flounder).

The O&M of the RWF, RWEC, and O&M facility would result in intermediate to long-term adverse effects on EFH habitat for some life stages of EFH species. Long-term adverse effects are those that would last over the approximately 35-year operating period of the Project, so would be effectively permanent. These impacts include alteration of water column and benthic habitats, operational noise, EMF and heat effects, hydrodynamic effects, and food web effects. Monopile foundations, scour protection, and cable protection would alter habitat. Benthic habitat areas mapped within the Lease Area consist of 17,945 acres of complex, 11,128 acres of large-grained complex, and 29,563 acres of soft-bottom benthic habitat. Foundation piles would displace approximately 0.6 acre of large-grained complex, 0.8 acre of complex, and 1.5 acres of soft-bottom benthic habitat within the maximum monopile footprint. An additional estimated 15.8 acres of large-grained complex, 23.8 acres of complex, and 39.5 acres of soft-bottom benthic habitat would be modified by placement of scour protection around the foundations and IAC protection. Approximately 14.5 acres of large-grained complex, 34.2 acres of complex, 90.4 acres of soft-bottom benthic habitat would be modified by IAC and OSS-link scour protection anticipated to be surface-laid. IAC and OSS-link boulder relocation would modify approximately 309.7 acres of large-grained complex, 701.7 acres of complex, and 90.4 acres of soft-bottom benthic habitat. The potential increase in abundance of epibenthic and demersal fishes resulting from the reef effect may offset some impacts to EFH of those species over the life of the Project, although it may take a decade or more for the reef effect to fully develop. Analyses of habitat impacts are found in Section 5. The implementation of EPMs would likely result in the avoidance and minimization of some of the intermediate to long-term (permanent) Project impacts to EFH species and their habitat described above. Overall, the construction and installation, O&M, and decommissioning of the Project would be expected to result in effects that range from **moderate** adverse to **moderate** beneficial (O&M, presence of structures) to **negligible** to **minor** adverse (for HVAC) and **moderate** adverse (for HVDC).

3.13.2.6 Alternatives C, D, E, and F: Finfish

3.13.2.6.1 Construction and Installation

Offshore Activities and Facilities

Noise: Alternatives C through F would result in similar noise impacts to finfish from WTG and OSS foundation installation to those described in Section 3.13.2.2.1 for the Proposed Action, but the duration and extent of those impacts would be reduced due to the reduced number of WTG and OSS foundations. These impacts would vary based on the reduced number of WTGs and/or OSS foundations installed under each alternative, depending on the configuration selected. Reducing the number of structures could also reduce the required extent of HRG surveys under each alternative relative to the Proposed Action, but BOEM has insufficient information to determine if this is the case. Similarly, it is not possible to determine if changes in foundation layout would alter the UXO detonation requirements relative to the Proposed Action because the probable area of occurrence within the RWF is large and centrally located within the wind farm footprint. Therefore, impacts to finfish from HRG surveys and UXO detonation are considered to be the same across all alternatives.

Differences in underwater noise impacts on finfish between the Proposed Action and the different configurations proposed for Alternatives C through E are summarized in Table 3.13-10, Table 3.13-11, and Table 3.13-12, respectively. These tables display the differences in the number of impact pile-driving sites and the estimated total duration of potentially harmful noise effects from pile-driving activities. While the alternatives would vary in terms of the number of impact pile-driving sites and total duration of pile-driving activities, the magnitude of impacts and general scale of effects would be similar to those under the Proposed Action.

Impact pile driving used to install the RWF monopile foundations and UXO detonation is the most intense source of noise resulting from the Project and would produce the most significant and extensive noise effects on fish. Pile-driving noise would exceed the cumulative injury and behavioral effects thresholds for finfish from 354 to 2,749 feet and nearly 35,000 feet (6.6 miles) from each foundation installation, respectively. These effects would occur at 64 to 93 sites for 22 to 31 days under Alternatives C through F, varying by the alternative configuration selected. Although the extent and duration of effects would vary between alternatives, the level of impact would be similar. However, configurations of Alternative C would reduce the level of activity and associated construction noise, such as pile driving, relative to the Proposed Action and Alternatives D, E (i.e., E2), and F. Alternative C configurations would also lead to less extensive impacts on areas within the Lease Area where Atlantic cod spawning activity has primarily been observed (i.e., Zone RWF 1) (Van Hoeck et al. 2023). Combining Alternatives C and F would result in further reductions of noise impacts due to the reduction in turbines and associated reductions in construction and installation activities that produce noise in areas that support spawning

Atlantic cod and other managed species that use large-grained complex and complex habitats. The EPMs committed to by Revolution Wind (see Table F-1, Appendix F) to reduce construction-related noise impacts would be the same as those described for Alternative B (e.g., TOY restrictions).

As stated, Revolution Wind has determined that all 16 UXOs identified in the RWEC corridor can be safely avoided without the need for detonation by shifting the installation route (Orsted 2023). However, it is possible that additional devices could be discovered in preconstruction surveys or during construction that cannot be avoided or safely relocated. BOEM has concluded that the need for UXO detonation cannot be entirely ruled out; therefore, the potential effects of this activity are considered. As stated in Table 3.13-5, UXO detonation could result in injury-level effects to finfish and fish eggs and larvae potentially extending up to 951 and 1,384 feet from the source, respectively. Therefore, construction noise effects on finfish resulting from Alternatives C through F would be the same as those under the Proposed Action, ranging from negligible to minor adverse.

Similar impacts as described for the Proposed Action for intermittent non-impulsive noise associated with vibratory pile driving, HRG surveys, and construction vessels would result from Alternatives C through F and would have a **negligible** to **minor** adverse impact. Potential effects to ESA-listed Atlantic sturgeon and giant manta ray under Alternatives C through F would be similar in intensity as those described for the Proposed Action but reduced in extent and therefore **negligible** to **minor** adverse.

Sediment deposition and burial: Alternatives C through F would result in similar sediment deposition and burial impacts on finfish to those described in Section 3.13.2.3.1 for the Proposed Action, but those impacts would be reduced in extent and the total area exposed would vary depending on the configuration selected. Differences in potential sediment deposition and burial exposure between the Proposed Action and the different configurations proposed for Alternatives C, D, and E are summarized in Table 3.6-23, Table 3.6-24, and Table 3.6-25 in Section 3.6.2.5.1, respectively, in terms of the estimated total acres exposed to sediment deposition and burial effects greater than 0.4 inch (10 mm) for each cable component.

Table 3.13-10. Comparison of Maximum Underwater Noise Injury and Behavioral Effects Exposure Extent and Duration by Fish Hearing Group from Revolution Wind Farm Wind Turbine Generator Foundation Installation, the Proposed Action, and Proposed Configurations for Alternative C*

Noise Exposure Type	Hearing Group	Threshold Distance (feet)†	Proposed Action (number of sites/days)	C1 (number of sites/days)	C2 (number of sites/days)
Peak injury	Fish–Swim bladder involved in hearing	348	100 sites/ 35 days	64 sites/ 22 days	65 sites/ 22 days
	Fish–Swim bladder not involved in hearing	348			
	Fish–No swim bladder	59			
	Eggs and larvae	348			
Cumulative injury	Fish–Swim bladder involved in hearing	2,749			
	Fish–Swim bladder not involved in hearing	1,680			
	Fish–No swim bladder	354			
	Eggs and larvae	1,680			
TTS	All fish	30,961			
Behavioral effects	All fish	34,987			

* Installation scenario for 12-m monopile is 6,500 strikes/pile at installation rate of three piles/day. All piles installed with a 4,000-kJ hammer with an attenuation system achieving 10-dB sound source reduction.

† Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur. WTG values are the range threshold distances for monopile installation modeled by Kusel et al. (2023) across modeled sites and seasonal conditions.

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Table 3.13-11. Comparison of Maximum Underwater Noise Injury and Behavioral Effects Exposure Extent and Duration by Fish Hearing Group from Revolution Wind Farm WTG Foundation Installation, the Proposed Action, and Proposed Configurations for Alternative D*

Exposure Type	Hearing Group	Threshold Distance (feet)†	Proposed Action (number of sites/days)	D1 (number of sites/days)	D2 (number of sites/days)	D3 (number of sites/days)	D1+D2 (number of sites/days)	D1+D3 (number of sites/days)	D2+D3 (number of sites/days)	D1+D2+D3 (number of sites/days)
Peak injury	Fish–Swim bladder involved in hearing	348	100 sites/ 35 days	93 sites/ 31 days	92 sites/ 31 days	93 sites/ 31 days	85 sites/ 28 days	86 sites/ 29 days	85 sites/ 28 days	78 sites/ 26 days
	Fish–Swim bladder not involved in hearing	348								
	Fish–No swim bladder	59								
	Eggs and larvae	348								
Cumulative Injury	Fish–Swim bladder involved in hearing	2,749								
	Fish–Swim bladder not involved in hearing	1,680								
	Fish–No swim bladder	354								
	Eggs and larvae	1,680								
TTS	All fish	30,961								
Behavioral effects	All fish	34,987								

* Installation scenario for 12-m monopile is 6,500 strikes/pile at installation rate of three piles/day. All piles installed with a 4,000-kJ hammer with an attenuation system achieving 10-dB sound source reduction.

† Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur. WTG values are the range threshold distances for monopile installation modeled by Kusel et al. (2023) across modeled sites and seasonal conditions.

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Table 3.13-12. Comparison of Maximum Underwater Noise Injury and Behavioral Effects Exposure Extent and Duration by Fish Hearing Group from Revolution Wind Farm Wind Turbine Generator Foundation Installation and Unexploded Ordnance Detonation, the Proposed Action, and Proposed Configurations for Alternative E*

Noise Exposure Type	Hearing Group	Threshold Distance (feet)†	Proposed Action (number of sites/days)	E1 (number of sites/days)	E2 (number of sites/days)
Peak injury	Fish–Swim bladder involved in hearing	348	100 sites/ 35 days	64 sites/ 22 days	81 sites/ 27 days
	Fish–Swim bladder not involved in hearing	348			
	Fish–No swim bladder	59			
	Eggs and larvae	348			
Cumulative Injury	Fish–Swim bladder involved in hearing	2,749			
	Fish–Swim bladder not involved in hearing	1,680			
	Fish–No swim bladder	354			
	Eggs and larvae	1,680			
TTS	All fish	30,961			
Behavioral effects	All fish	34,987			

* Installation scenario for 12-m monopile is 6,500 strikes/pile at installation rate of three piles/day. All piles installed with a 4,000-kJ hammer with an attenuation system achieving 10-dB sound source reduction.

† Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur. WTG values are the range threshold distances for monopile installation modeled by Kusel et al. (2023) across modeled sites and seasonal conditions.

The various configurations of Alternatives C through F would modify the installation length for the IAC. This would reduce the extent of sediment deposition and burial effects for IAC installation relative to the Proposed Action. Alternative C would also alter the distribution of sediment deposition impacts by avoiding large blocks of complex and large-grained complex habitat, meaning that finfish associated with those habitats would be less likely to experience deposition effects. Alternatives C through F would not change the proposed configurations of the OSS-link cable and RWEC; therefore, sediment deposition and burial effects for these Project components would not change. While this alternative would result in a slightly smaller area exposed to potentially harmful sediment deposition impacts, overall impacts would not change relative to the Proposed Action and would range from **negligible** to **minor** adverse.

3.13.2.6.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Presence of structures: As discussed for benthic habitat in Section 3.6.2.4.2, Alternatives C through F would result in the installation of fewer monopile foundations than the Proposed Action and would reduce the total length of IAC. This would noticeably reduce the extent of long-term to permanent impacts on finfish, particularly those species that associate with benthic habitats within the RWF maximum work area.

Differences between the Proposed Action and alternate configurations of Alternatives C through E in benthic habitat acreage occupied by new structures are illustrated in Section 3.6.2.4.2, Table 3.6-17, Table 3.6-18, and Table 3.6-19. Alternative F would employ one of the proposed Alternative C through E configurations and would otherwise be identical except that it would use higher capacity WTGs. As such, impacts from this IPF on finfish habitat would be identical to those described for the selected alternative configuration. As shown, Alternatives C through F would reduce the number of WTG foundations and the total acres of IAC relative to the Proposed Action. This would result in a commensurate reduction in the acres of benthic habitat exposed to short- and long-term impacts from the presence of foundations and scour and cable protection, resulting effects on finfish that associate with these habitats.

Alternatives C through F would produce reef and hydrodynamic effects from structure presence similar in nature but reduced in extent relative to those described for the Proposed Action in Section 3.6.2.3.2. The resulting effects on finfish, invertebrates, and other organisms would be reduced in extent under each alternative configuration commensurate with the number of structures and acres of cable protection installed (see Table 3.6-14, Table 3.6-15, and Table 3.6-16 for Alternatives C through E) but would be of the same general scale and overall impact as those produced by the Proposed Action. These effects would therefore range from **minor** to **moderate** adverse or **moderate** beneficial, as measured by potential effects on the broader biological community associated with benthic habitats using the significance criteria defined in Section 3.3, Table 3.3-2.

As discussed for Project construction, these impact determinations do not differentiate potentially important differences in impacts between alternatives. Specifically, the proposed configurations of Alternative C were specifically selected to avoid and minimize impacts to large-grained complex and complex habitats of value for certain fish species of concern. This would in turn reduce the extent of impacts for species, such as Atlantic cod, that associate with specific complex benthic habitats on Cox Ledge within the proposed RWF footprint. As discussed in Section 3.13.2.3.2, the Proposed Action is likely to result in complex reef and hydrodynamic effects that could influence habitat conditions for a variety of finfish species that occur in the region. Many of these effects are uncertain and could be positive, negative, or neutral depending on the fish species in question and the alternative-specific nature of the effects. For example, the hydrodynamic effects of the Proposed Action are likely to have noticeable effects on the dispersal patterns of silver hake eggs and larvae (Johnson et al. 2021). However, the resulting localized shifts in larval settlement density are likely to be biologically insignificant given that this species spawns in large aggregations and disperses larvae over broad areas at regional scales (Johnson et al. 2021). In contrast, changes in egg and larvae dispersal patterns could be more significant for species like Atlantic cod that spawn in specific areas and rely on the conditions present to carry their pelagic eggs and larvae to areas that are favorable for survival and recruitment. While hydrodynamic effects could lead to localized shifts in larval settlement density, it is not currently known if this would have any measurable effects on larval survival or population productivity. Therefore, while Alternatives C through F would reduce hydrodynamic effects by varying degrees relative to the Proposed Action, it is not possible to determine if this would result in measurable differences between alternatives in impacts to finfish.

3.13.2.6.3 Cumulative Impacts

Offshore Activities and Facilities

The finfish cumulative impacts analysis for Alternatives C, D, E, and F is provided in Table 3.13-3.

3.13.2.6.4 Conclusions

The construction and installation, O&M, and decommissioning of Alternatives C through F would impact finfish through several mechanisms, including short-term and long-term habitat disturbance, permanent habitat conversion, and changes in substrate composition and nutrient cycling from reef effects caused by colonization of structures by habitat-forming invertebrates. These effects would alter the structure and function of finfish habitats within the RWF and portions of the RWEC corridor where cable protection is used and create new biological hotspots that would benefit some fish species. Long-term to permanent habitat conversion effects on seafloor from boulder relocation and the presence of structures would constitute a **moderate** adverse effect on finfish. These adverse effects would be offset by **moderate** beneficial effects on some finfish species that benefit from reef effects. While the overall extent of effects to finfish would be reduced under Alternatives C through F relative to the Proposed Action, the significance of those effects would be the same.

3.13.2.7 Alternatives C, D, E, and F: Essential Fish Habitat

Table 3.13-3 provides a summary of potential construction and installation impacts to EFH and a comparison of all evaluated IPFs for EFH across alternatives. Potential construction and installation impacts to EFH elements under Alternatives C, D, E, and F are addressed in Section 3.13.2.6 Finfish, Section 3.6.2.6 Benthic Habitat, and Section 3.6.2.7 Invertebrates.

3.13.2.7.1 Conclusions

The construction and installation, O&M, and decommissioning of Alternatives C through F would impact EFH through the same mechanisms described for the Proposed Action, including short-term and long-term habitat disturbance, permanent habitat conversion, and changes in substrate composition and nutrient cycling from reef effects caused by structures. Overall the construction and installation, O&M, and decommission of Alternatives C through F would be expected to result in effects that are similar to the Proposed Action and range from **moderate** beneficial (O&M, presence of structures) to **moderate** adverse. However, configurations of Alternative C would reduce the level of activity and associated construction noise, such as pile driving, relative to the Proposed Action and Alternatives D, E, and F. Alternative C configurations would also lead to less extensive impacts on areas within the Lease Area where Atlantic cod spawning activity has primarily been observed (i.e., Zone RWF 1) (Van Hoeck et al. 2023). Combining Alternatives C and F would result in further reductions of noise impacts due to the reduction in turbines and associated reductions in construction and installation activities that produce noise in areas that support spawning Atlantic cod and other managed species that use large-grained complex and complex habitats.

3.13.2.8 Alternative G: Impacts of the Preferred Alternative on Finfish

3.13.2.8.1 Construction and Installation

Table 3.13-3 provides a comparison of all evaluated IPFs for EFH across alternatives.

Offshore Activities and Facilities

Noise: Construction of Alternative G would result in similar noise impacts to finfish from WTG and OSS foundation installation to those described in Section 3.13.2.2.1 for the Proposed Action and in Section 3.13.2.6.1 for Alternatives C through F, but those impacts would be reduced in extent and duration. Configurations of Alternative G would reduce the level of construction activity and associated noise due to the reduction in turbines compared to the Proposed Action and Alternatives D, E, and F, particularly in areas of complex and large-grained complex habitats that support managed finfish and cod spawning (i.e., reduced construction noise impacts in Zones RWF 1 and 2). Alternative G1 would result in slight reductions of construction noise in the central portion of Zone RWF 1 compared to Alternatives G, G2, and G3, where most of the recent cod spawning activity within the Lease Area has been observed (Van Hoeck et al. 2023). However, Alternative G1 would still result in construction noise that would overlap areas in Zone RWF 1 observed to support spawning cod relative to Alternative C, which avoids the placement of any WTGs in RWF Zone 1 and throughout most of Zone RWF 2.

EPMs committed to by Revolution Wind (see Table F-1, Appendix F), including ramp-up/soft starts and TOY restrictions for pile-driving activity (January through April), would reduce the magnitude and temporal extent of impacts to Atlantic cod spawning, which existing data indicate is occurring both within (primarily in Zone RWF 1) and outside the Lease Area between October and March (DeCelles et al. 2017; Inspire Environmental 2019a, 2020; Van Hoeck et al. 2023). In addition, Revolution Wind would coordinate with RIDEM and NOAA NMFS regarding TOY restrictions through the permitting process and will adhere to requirements imposed by these agencies (e.g., TOY restrictions to avoid and/or minimize impacts to winter flounder). Given this, construction noise effects on finfish resulting from Alternative G would be the same as the Proposed Action, ranging from **minor** to **moderate** adverse.

UXO detonation may be required during site preparation for construction, and the largest UXO devices are most likely to be found within the central portion of the RWF and in state waters on the RWEC corridor at the mouth and outside of Narragansett Bay (Ordtek 2021). This probable area of occurrence covers a large enough portion of the RWF such that it is not currently possible to assess potential differences in associated noise impacts between alternatives and the area of potential adverse effects from

UXO detonation would be the same across alternatives. Similarly, although reducing the number of foundations and IAC length would also likely reduce HRG survey requirements, insufficient information is available to quantify differences in noise exposure area between alternatives. However, any difference in UXO- or HRG-related noise exposure would not be sufficient to alter the noise impact determination for finfish. Applying the impact criteria defined in Section 3.3, Table 3.3-2, construction noise effects on finfish from Alternative G would be the same as the Proposed Action: **minor** to **moderate** adverse.

Similar impacts as described for the Proposed Action for intermittent non-impulsive noise associated with vibratory pile driving, HRG surveys, and construction vessels would result from Alternative G and would have a **negligible** to **minor** adverse impact. Potential effects to ESA-listed Atlantic sturgeon, giant manta ray, and shortnose sturgeon under Alternative G would be similar in intensity as those described for the Proposed Action but reduced in extent and therefore **negligible** to **minor** adverse.

Sediment deposition and burial: Alternative G would result in similar sediment deposition and burial impacts on finfish to those described in Section 3.13.2.3.1 for the Proposed Action and in Section 3.13.2.6.1 for Alternatives C through F, but reduced in extent. Alternative G would reduce total IAC length, reducing the overall footprint of sediment impacts. Alternative G would also reduce cable installation length in sediments with a high proportion of mud and silt from 3.2 to 2.8 miles relative to the Proposed Action.

Differences in potential sediment deposition and burial exposure between the Proposed Action and Alternative G are summarized in Table 3.6-33 in terms of the estimated total acres exposed to sediment deposition and burial effects greater than 0.4 inch (10 mm) for each cable component. As shown, Alternative G would reduce the total acreage exposed to sediment deposition and burial effects above this threshold from 217 to 162 acres relative to the Proposed Action, commensurately reducing the extent of biologically significant sediment burial effects. Alternative G would also alter the distribution of sediment deposition impacts by avoiding large blocks of complex and large-grained complex habitat, meaning that finfish associated with those habitats would be less likely to experience deposition effects. As currently designed, Alternative G would not change the proposed configurations of the OSS-link cable and RWEC; therefore, sediment deposition and burial effects for these Project components would be similar to those produced by the Proposed Action. Although these alternatives would result in a slightly smaller area exposed to potentially harmful sediment deposition impacts, the level of impact would be the same as under the Proposed Action. Therefore, short-term sediment deposition and burial effects on finfish would range from **negligible** to **minor** adverse.

3.13.2.8.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Presence of structures: As discussed for benthic habitat in Section 3.6.2.4.2 and in Section 3.13.2.6.2 for Alternatives C through F, Alternative G would result in the installation of fewer monopile foundations within sensitive habitats important to EFH species than the Proposed Action and Alternatives D, E, and F and would reduce the total length of IAC. This would noticeably reduce the extent of long-term to permanent impacts on finfish, particularly those species that associate with benthic habitats within the RWF maximum work area.

Alternative G would produce reef and hydrodynamic effects from structure presence similar in nature but reduced in extent relative to those described for the Proposed Action in Section 3.6.2.3.2 and in Section 3.13.2.6.2 for Alternatives D, E, and F. Reef and hydrodynamic effects from structure presence would be increased under Alternative G in areas that support Atlantic cod spawning relative to Alternative C, which would remove all WTGs from Zone RWF 1 and most of the WTGs in Zone RWF 2. Alternative G1 would result in slightly fewer effects due to the presence of structures in the central portion of Zone RWF 1 compared to the Proposed Action and Alternatives D, E, F, and G (i.e., G, G2, and G3). Most of the Atlantic cod spawning observations have been recorded in these areas (Van Hoeck et al. 2023). Differences between the Proposed Action and Alternative G in terms of benthic habitat occupied by new structures are shown in Section 3.6.2.8.2, Table 3.6-33. The resulting effects on finfish and other organisms would be reduced in extent but would be of the same general scale and overall impact as those produced by the Proposed Action. These effects would therefore range from **minor** to **moderate** adverse or **moderate** beneficial, as measured by potential effects on the broader biological community associated with benthic habitats using the significance criteria defined in Section 3.3, Table 3.3-2.

As discussed for Project construction, these impact determinations do not differentiate potentially important differences in impacts between alternatives. Alternative G would avoid portions of the RWF comprising predominantly large-grained complex and complex habitats of value for certain fish species of concern. Alternative G1 would result in fewer long-term to permanent impacts compared to Alternatives G2 and G3 because the presence of structures in the central portion of Zone RWF 1 under Alternatives G2 and G3 are where most of the recent cod spawning activity within the Lease Area has been observed (Van Hoeck et al. 2023). Avoiding these areas would reduce the extent of impacts for finfish species, including Atlantic cod, that associate with complex benthic habitat compared to the Proposed Action. These potential benefits are acknowledged and discussed in greater detail in terms of potential effects on habitat suitability for certain finfish and EFH invertebrate species of concern in Sections 3.13.2.4.1.

3.13.2.8.3 Cumulative Impacts

Offshore Activities and Facilities

Accidental releases and discharges: Based on compliance with environmental regulations, Alternative G when combined with past, present, and reasonably foreseeable projects would result in in **negligible** to **minor** adverse cumulative impacts on EFH ranging from short term to long term in duration. The rationale for this conclusion is the same as described for the Proposed Action.

When the Project is combined with other future offshore wind projects, up to approximately 34 million gallons of coolants, fuels, oils, and lubricants could cumulatively be stored within WTGs and the OSSs within the finfish GAA. All vessels associated with the Project and other offshore wind projects would comply with USCG requirements for the prevention and control of oil and fuel spills. Additionally, training and awareness of EPMs (see Table G-1 in Appendix G) proposed for waste management and marine debris would be required of RWF Project personnel. These releases, if any, would occur infrequently at discrete locations and vary widely in space and time, and impacts would be minimized through planned EPMs and other mitigation measures detailed in Tables F-1 and F-2, respectively, in Appendix F. Although unlikely, unanticipated events could result in larger spill events, leading to cumulative impacts of greater severity and duration, similar to those described for the Proposed Action.

Anchoring and new cable emplacement/maintenance: BOEM estimates a cumulative total of 10,525 acres of anchoring and mooring-related disturbance and 104,781 acres of cabling-related disturbance for Alternative G plus all other future offshore wind projects within the GAA. The duration and magnitude of these effects would vary depending on the types of habitats impacted. Impacts on soft-bottom benthic habitats and associated finfish species would be expected to fully recover within 18 to 30 months, whereas impacts on complex benthic habitats could take up to a decade to fully recover.

On this basis, Alternative G when combined with past, present, and reasonably foreseeable projects would result in **minor** to **moderate** adverse cumulative impacts to finfish and on benthic habitat structure through impacts to habitat-forming invertebrates.

Bycatch: Like the Proposed Action, Alternative G would include implementation of the FRMP proposed to evaluate the effects of Project construction and O&M on economically valuable fish resources (Revolution Wind and Inspire Environmental 2023). No revisions to the FRMP are proposed based on changes in alternative configuration. Given this, cumulative impacts from bycatch associated with monitoring activities under the Proposed Action in combination with other planned and future offshore wind projects would be **minor** adverse, with the impacts ranging from short term to long term in duration.

Climate change: Cumulative impacts to habitat structure from climate change under Alternative G are expected to be of similar magnitude to those described for the Proposed Action. Under the Proposed Action, the intensity of climate change cumulative impacts on finfish are uncertain but are likely to result in **moderate** adverse effects that vary considerably between species.

Noise: Alternative G would generate underwater noise effects during Project construction, throughout the operational life of the Project, and during Project decommissioning. Those impacts would be similar in magnitude and distribution but reduced in extent relative to the Proposed Action. These effects would combine with similar effects resulting from the construction, O&M, and decommissioning of other planned offshore wind projects on the Mid-Atlantic OCS. Sound-sensitive finfish species occurring in proximity to impact or vibratory pile driving and/or UXO detonation could suffer noise-related injury to sensory cells, resulting in reduced survival. The number of individuals affected is unlikely to have any measurable effect on those species at the population level. Less sensitive species may be temporarily disturbed by vibration effects, but any such effects would be short term in duration and are unlikely to have a measurable effect on any population. On this basis, cumulative effects on finfish resulting from underwater noise caused by Alternative G are likely to be **negligible** to **minor** adverse, varying by species.

Presence of structures: Alternative G would result in the long-term alteration of water column and seafloor habitats, resulting in a diversity of effects on finfish, including EFH species. The 67 monopile foundations and other hard surfaces proposed under the four configurations of Alternative G would create an artificial reef effect and cause hydrodynamic effects. The long-term to permanent effects of these structures would influence primary and secondary productivity within and around the artificial reef and influence the distribution and productivity of planktonic invertebrates, eggs, and larvae. Reef effects would alter biological community structure, producing an array of effects on finfish. Those cumulative effects could be beneficial or adverse, varying by species, and would likely range from **moderate** adverse to **moderate** beneficial in terms of overall impact.

Sediment deposition and burial: Alternative G in combination with future offshore wind projects would generate similar sediment deposition and burial effects to those described in Section 3.13.2.2.3. When combined with other past, present, and reasonably foreseeable actions, Alternative G would result in **minor** adverse cumulative impacts on finfish.

3.13.2.8.4 Conclusions

The construction and installation, O&M, and decommissioning of Alternative G would impact finfish through several mechanisms, including short-term and long-term habitat disturbance, permanent habitat conversion, and changes in substrate composition and nutrient cycling from reef effects caused by colonization of structures by habitat-forming invertebrates. These effects would alter the structure and function of finfish habitats within the RWF and portions of the RWEC corridor where cable protection is used and create new biological hotspots that would benefit some fish species. Long-term to permanent habitat conversion effects on seafloor from boulder relocation and the presence of structures would constitute a **moderate** adverse effect on finfish. These adverse effects would be offset by **moderate** beneficial effects on some finfish species that benefit from reef effects. Although the overall extent of effects to finfish would be reduced under Alternative G, relative to the Proposed Action and Alternatives D, E, and F, the significance of those effects would be the same. The extent of potential effects (e.g., disruptions to spawning activity from construction noise and anchoring/cable emplacement/seafloor preparation) to spawning Atlantic cod would be increased under Alternative G relative to Alternative C, which removes all WTGs from Zone RWF 1 and most of the WTGs from Zone RWF 2.

3.13.2.9 Alternative G: Impacts of the Preferred Alternative on Essential Fish Habitat

Table 3.13-3 provides a summary of potential construction and installation impacts to EFH and a comparison of all evaluated IPFs for EFH across alternatives. Potential construction and installation impacts to EFH elements under Alternative G are also addressed in Section 3.13.2.8 Finfish, Section 3.6.2.8 Benthic Habitat, and Section 3.6.2.9 Invertebrates.

3.13.2.9.1 Conclusions

The construction and installation, O&M, and decommissioning of Alternative G would impact EFH through the same mechanisms described for the Proposed Action, including short-term and long-term habitat disturbance, permanent habitat conversion, and changes in substrate composition and nutrient cycling from reef effects caused by structures. Overall, the construction and installation, O&M, and decommission of Alternative G would be expected to result in effects that are similar to the Proposed Action and range from **moderate** beneficial (O&M, presence of structures) to **moderate** adverse. Although the overall extent of effects to EFH would be reduced under Alternative G, relative to the Proposed Action and Alternatives D, E, and F, the significance of those effects would be the same. The extent of effects to areas of contiguous, large-grained complex and complex habitats between Zone RWF 1 and Zone RWF 2 that support Atlantic cod spawning and managed finfish would be increased under Alternative G (all configurations) relative to Alternative C, which removes all WTGs from Zone RWF 1 and most of the WTGs from Zone RWF 2. This would include reductions in IACs and associated effects.

Long-term to permanent habitat disturbance effects on an estimated 1,740 acres of large-grained complex and complex habitats from vessel anchoring, cable installation and cable protection, seafloor preparation for foundation installation, and the presence of foundations and scour protection would result from

Alternative G. An estimated 125 acres of soft-bottomed habitat would be converted to hard bottom by the presence of structures, scour protection, and cable protection compared to 131 acres for Alternative G. Collectively, these effects would constitute a **moderate** adverse effect on EFH habitat, resulting from habitat conversion and long-term impacts to certain types of habitat-forming organisms. These adverse effects would be partially offset by **moderate** beneficial effects on EFH habitat structure and productivity resulting from reef effects. The colonization of artificial structures by a complex community of habitat-forming organisms would increase the structural complexity of benthic habitat in and around WTG and OSS foundations. Some EFH habitat effects could persist even after the Project is decommissioned. For example, reef effects would result in shell hash accumulation around foundations that would remain after the structures are removed. This would alter the composition of sediments within the RWF beyond the life of the Project but would not be expected to negatively affect the ability of benthic habitats to support ecosystem function after the Project is decommissioned.

Collectively, BOEM anticipates that the overall impacts from offshore activities associated with the Proposed Action when combined other with past, present, and reasonably foreseeable activities would result in notable and measurable impacts on benthic habitat. Some of these impacts could persist after the Project is decommissioned, but they would not prevent full recovery of ecosystem function. These findings would constitute a **moderate** adverse impact on EFH habitat composition and **moderate** adverse to **moderate** beneficial effects on EFH habitat structure in the GAA.

3.13.2.10 Mitigation

Mitigation measures resulting from agency consultations for finfish and EFH are identified in Appendix F, Table F-2, and addressed in Table 3.13-13. Additional mitigation measures identified by BOEM and cooperating agencies are described in detail in Appendix F, Table F-3, and addressed in Table 3.13-14. If one or more of the measures analyzed below are adopted by BOEM and/or cooperating agencies, some adverse impacts could be further reduced.

Table 3.13-13. Mitigation and Monitoring Measures Resulting from Consultations for Finfish and Essential Fish Habitat (Appendix F, Table F-2)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
DRAFT NMFS BiOp Reasonable and Prudent Measures (RPMs) and Terms and Conditions (T&Cs)*	Draft NMFS Biological Opinion Proposed Reasonable and Prudent Measures were issued to BOEM for consideration on June 16, 2023. Final NMFS Biological Opinion Proposed Reasonable and Prudent Measures to be issued to BOEM for consideration on July 21, 2023. RPMs and Terms and Conditions to minimize the impact of incidental take of ESA-listed species were documented in excerpts from the Draft NMFS Biological Opinion dated June 16, 2023. These measures include adherence to mitigation measures to minimize impacts to ESA-listed Atlantic sturgeon from pile driving and UXO detonation; compliance with requirements for vessel operations within the Delaware River and Delaware Bay included in the Incidental Take Statements provided with the Paulsboro Marine Terminal Biological Opinion (dated July 19, 2022) to minimize vessel impacts to ESA listed sturgeon; reporting requirements related to effects to, or interactions with, ESA listed species; submittal of required plans (e.g., PSO Training Plan for Trawl Surveys, Cofferdam Installation and Removal Monitoring Plan, Sound Field Verification Plan), to NMFS GARFO with sufficient time for review, comment and approval; and conducting on-site observation and inspection to gather information on the effectiveness and implementation of measures to minimize and monitor incidental take.	These RPMs and Terms and Conditions would minimize the exposure of ESA-listed species to pile driving noise and the effects of UXO detonation. These RPMs and Terms and Conditions would also ensure that all incidental take that occurs is documented and reported to NMFS in a timely manner and that any incidentally taken individual specimens are properly handled, resuscitated if necessary, transported for additional care or reporting, or returned to the sea. Reporting requirements to document take would improve accountability for documenting take associated with the Proposed Action. In some cases, these RPMs and Terms and Conditions provide additional detail or clarification of measures that are included as part of the Proposed Action. Implementation of these RPMs and Terms and Conditions would provide incremental reductions in impacts on finfish, invertebrates, and sensitive habitats, including EFH, and would improve accountability, but would not alter the overall impact determination of the Proposed Action.
NMFS EFH Conservation Recommendations	NMFS EFH Conservation Recommendations were issued to BOEM for consideration on June 16, 2023 (NMFS 2023). EFH Conservation Recommendations for activities under BOEM's jurisdiction were provided identifying proposed removal and relocation (micrositing) of selected WTG foundations and cable segments removal and relocation; construction timing restrictions to avoid potential adverse impacts to Atlantic cod; habitat alteration minimization; noise mitigation; and minimization of impacts during construction, O&M, and decommissioning. EFH Conservation Recommendations for activities under USACE's jurisdiction were provided for in-water work; offshore impact minimization; impact to scientific surveys minimization; and	Implementation of Conservation Recommendations, including eliminating WTG foundations, micrositing WTGs and cable segments, scour protection avoidance, anchoring avoidance, minimizing boulder/cobble relocation distance, and cable re-routing, would minimize known or reasonably foreseeable adverse impacts on EFH, including large-grained complex and complex benthic habitats on Cox Ledge, and identified Atlantic cod spawning sites. Conservation recommendations for timing restrictions on all construction activity in the Lease Area from November 1 to April 30, and noise mitigation during

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	identification and facilitated access to mapping of relocated boulders, berms, scour, and cable protection.	construction, such as soft starts, use of noise-dampening equipment, and noise mitigation protocols in consultation with resource agencies prior to construction activities, would avoid and minimize potential noise impacts on EFH species and habitat. Implementation of Conservation Recommendations to revise the Fisheries and Benthic Habitat Monitoring Plan and develop monitoring plans for EMF and operational noise and vibration effects would benefit EFH habitats and species by ensuring robust experimental design, methods, and data collection/analysis to assess changes in habitat conditions. Although implementation of the Conservation Recommendations would provide incremental reductions in impacts on large-grained complex and complex habitats and associated EFH, reductions in the overall impact rating are not anticipated for any of the Proposed Action's IPFs.
Live and hard-bottom impact monitoring	Revolution Wind would develop and implement a monitoring plan for live and hard-bottom features that may be impacted by proposed activities. The monitoring plan would also include assessing the recovery time for these sensitive habitats. BOEM recommends that all monitoring reports classify substrate conditions following Coastal and Marine Ecological Classification Standard (CMECS) standards, including live bottoms (e.g., submerged aquatic vegetation and corals and topographic features). The plan would also include a means of recording observations of any increased coverage of invasive species in the impacted hard-bottom areas.	This measure would not modify the impact determination for finfish or EFH or reduce the potential impacts from the project, but it would provide information that can be used to inform the development of future mitigations and/or monitoring programs for the Project and other projects in the region.
Live and hard-bottom habitat mapping and avoidance	Vessel operators would be provided with maps of sensitive hard-bottom habitat in OSW project areas, as well as a proposed anchoring plan that would avoid or minimize impacts on the hard-bottom habitat to the greatest extent practicable. These plans	This measure would not modify the impact determination for finfish or EFH, but it would reduce impacts to sensitive and slow-to-recover large-grained complex and complex habitats used by EFH species.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	would be provided for all anchoring activity, including construction, maintenance, and decommissioning.	
Atlantic cod spawning monitoring plan	At least 90 days prior to IAC installation (e.g., boulder relocation, pre-cut trenching, cable crossing installation, cable lay and burial) and foundation site preparation (e.g., scour protection installation), BOEM would require Revolution Wind to provide DOI with a plan to monitor for Atlantic cod aggregations that are indicative of spawning behavior during the above-listed activities between November 1 and March 30 of each year (Plan). The objective of the Plan is to detect Atlantic cod aggregations and avoid or minimize the above-listed activities in any area with aggregations of Atlantic cod indicative of spawning behavior, as technically and economically feasible. Revolution Wind must include in the Plan details on detection thresholds (e.g., density and location) of spawning Atlantic cod aggregations that would trigger the adaptive management of activities described in this paragraph, including any restrictions on activities in any area with aggregations of Atlantic cod indicative of spawning behavior, and analysis of technical and/or economic infeasibility.	This measure would not modify the impact determination for construction noise effects on finfish or EFH, but it would identify spawning cod aggregations and reduce impacts during spawning periods to ensure that that these effects do not exceed the levels analyzed herein.
Anchoring plan	BOEM would require Revolution Wind to develop an anchoring plan to avoid or minimize adverse impacts on benthic habitat during Project construction and from O&M activities throughout the life of the Project. The anchoring plan must delineate sensitive large-grained complex and complex habitats, including eelgrass and kelp beds, and identify areas where anchoring activities are restricted.	This measure would not modify the impact determination for finfish or EFH, but it would reduce impacts to sensitive and slow-to-recover large-grained complex and complex habitats used by EFH species.
Marine debris awareness training	The Lessee would ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: 1) viewing a marine trash and debris training video or slide show (described below) and 2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at	This measure would not modify the impact determination for finfish or EFH, but it would provide the training, reporting, and enforcement mechanisms necessary to ensure that effects from accidental releases and discharges do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities must continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process must include the following elements: • Viewing of either a video or slide show by the personnel specified above • An explanation from management personnel that emphasizes their commitment to the requirements • Attendance measures (initial and annual) • Recordkeeping and the availability of records for inspection by DOI By January 31 of each year, the Lessee would submit to the DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE via TIMSWeb with a notification email (at marinedebris@bsee.gov).	
Marine debris elimination	Materials, equipment, tools, containers, and other items used in OCS activities that could be lost or discarded overboard must be clearly marked with the vessel or facility identification. All markings must clearly identify the owner and must be durable enough to resist the effects of the environmental conditions to which they may be exposed. Materials, equipment, tools, containers, and other items used in OCS activities which could be lost or discarded overboard must be properly secured to prevent loss overboard.	This measure would not modify the impact determination for finfish or EFH, but it would provide an enforcement mechanism to ensure that effects from accidental releases and discharges do not exceed the levels analyzed herein.
Data collection BA BMPs	BOEM and BSEE would ensure that all Project design criteria and best management practices incorporated in the Atlantic Data Collection Consultation for Offshore Wind Activities (BOEM 2021b)	This measure would not modify the impact determination for finfish or EFH, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	shall be applied to activities associated with the construction, maintenance and operations of the Project as applicable.	
Sampling gear	All sampling gear would be hauled out at least once every 30 days, and all gear must be removed from the water and all gear must be removed from the water and stored on land between survey seasons to minimize risk of entanglement.	This measure would not modify the impact determination for finfish or EFH, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.
Lost survey gear	If any survey gear is lost, all reasonable efforts that do not compromise human safety must be undertaken to recover the gear. All lost gear must be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (via TIMSWeb and notification email at marinedebris@bsee.gov) within 24 hours of the documented time of missing or lost gear. This report must include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	This measure would not modify the impact determination for finfish or EFH, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.
Survey training	At least one of the survey staff onboard the trawl surveys and ventless trap surveys must have completed Northeast Fisheries Observer Program (NEFOP) observer training (within the last 5 years) or other training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon). Reference materials for identification, disentanglement, safe handling, and genetic sampling procedures must be available on board each survey vessel. BOEM and BSEE would ensure that Revolution Wind prepares a training plan that addresses how this requirement would be met and that the plan is submitted to NMFS in advance of any trawl or trap surveys. This requirement is in place for any trips where gear is set or hauled.	This measure would not modify the impact determination for finfish or EFH, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.
Sea turtle/Atlantic sturgeon identification and data collection	Any sea turtles or Atlantic sturgeon caught and/or retrieved in any fisheries' survey gear must first be identified to species or species group. Each ESA-listed species caught and/or retrieved must then be properly documented using appropriate equipment and data collection forms. Biological data, samples, and tagging must occur as outlined below. Live, uninjured animals should be returned to	This measure would not modify the impact determination for finfish or EFH, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	the water as quickly as possible after completing the required handling and documentation. a. The *Sturgeon and Sea Turtle Take Standard Operating Procedures* must be followed (NOAA 2021a; https://media.fisheries.noaa.gov/dammigration/sturgeon_&_sea_turtle_take_sops_external.pdf).). b. Survey vessels must have a passive integrated transponder (PIT) tag reader onboard capable of reading 134.2-kilohertz and 125-kilohertz encrypted tags (e.g., Biomark GPR Plus Handheld PIT Tag Reader), and this reader be used to scan any captured sea turtles and sturgeon for tags. Any recorded tags must be recorded on the take reporting form (see below). c. Genetic samples must be taken from all captured Atlantic sturgeon (alive or dead) to allow for identification of the distinct population segment (DPS) of origin of captured individuals and tracking of the amount of incidental take. This must be done in accordance with the *Procedure for Obtaining Fin Clips from Sturgeon for Genetic Analysis* (NOAA 2019; https://media.fisheries.noaa.gov/dammigration/sturgeon_genetics_sampling_revised_june_2019.pdf). i. Fin clips must be sent to a NMFS-approved laboratory capable of performing genetic analysis and assignment to DPS of origin. To the extent authorized by law, BOEM is responsible for the cost of the genetic analysis. Arrangements must be made for shipping and analysis in advance of submission of any samples; these arrangements must be confirmed in writing to NMFS within 60 days of the receipt of this incidental take statement (ITS). Results of genetic analysis, including assigned DPS of origin, must be submitted to NMFS within 6 months of the sample collection.	

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	ii. Subsamples of all fin clips and accompanying metadata forms must be held and submitted to a tissue repository (e.g., the Atlantic Coast Sturgeon Tissue Research Repository) on a quarterly basis. The Sturgeon Genetic Sample Submission Form is available for download at https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic. d. All captured sea turtles and Atlantic sturgeon must be documented with required measurements and photographs. The animal's condition and any marks or injuries must be described. This information must be entered as part of the record for each incidental take. A NMFS Take Report Form would be filled out for each individual sturgeon and sea turtle (download at: https://media.fisheries.noaa.gov/2021-11/Sturgeon-Sea-Turtle-Take-SOPs-external-11032021.pdf).	
Sea turtle/Atlantic sturgeon handling and resuscitation guidelines	Any sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys must be handled and resuscitated (if unresponsive) according to established protocols and whenever at-sea conditions are safe for those handling and resuscitating the animal(s) to do so. Specifically: a. Priority must be given to the handling and resuscitation of any sea turtles or sturgeon that are captured in the gear being used, if conditions at sea are safe to do so. Handling times for these species should be minimized (i.e., kept to 15 minutes or less) to limit the amount of stress placed on the animals. b. All survey vessels must have copies of the sea turtle handling and resuscitation requirements found at 50 CFR 223.206(d)(1) prior to the commencement of any on-water activity (download at: https://media.fisheries.noaa.gov/dammigration/sea_turtle_handling_and_resuscitation_measures.pdf). These handling and resuscitation procedures	This measure would not modify the impact determination for finfish or EFH, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	must be carried out any time a sea turtle is incidentally captured and brought onboard the vessel during the proposed actions. c. If any sea turtles that appear injured, sick, or distressed, are caught and retrieved in fisheries survey gear, survey staff must immediately contact the Greater Atlantic Region Marine Animal Hotline at 866-755-6622 for further instructions and guidance on handling the animal, and potential coordination of transfer to a rehabilitation facility. If unable to contact the hotline (e.g., due to distance from shore or lack of ability to communicate via phone), the USCG should be contacted via VHF marine radio on Channel 16. If required, hard-shelled sea turtles (i.e., non- leatherbacks) may be held on board for up to 24 hours following handling instructions provided by the Hotline, prior to transfer to a rehabilitation facility. d. Attempts must be made to resuscitate any Atlantic sturgeon that are unresponsive or comatose by providing a running source of water over the gills as described in the sturgeon resuscitation guidelines (NOAA 2020; https://media.fisheries.noaa.gov/dammigration-miss/Resuscitation-Cards-120513.pdf). e. Provided that appropriate cold storage facilities are available on the survey vessel, following the report of a dead sea turtle or sturgeon to NMFS, and if NMFS requests, any dead sea turtle or Atlantic sturgeon must be retained on board the survey vessel for transfer to an appropriately permitted partner or facility on shore as safe to do so. f. Any live sea turtles or Atlantic sturgeon caught and retrieved in gear used in any fisheries survey must ultimately be released according to established protocols and whenever at-sea conditions are safe for those releasing the animal(s) to do so.	

Mitigation Measure	**Description**	**Expected Effect on Impacts from Action Alternatives**
Take notification	GARFO Protected Resources Division (PRD) and BSEE must be notified as soon as possible of all observed takes of sea turtles and Atlantic sturgeon occurring as a result of any fisheries survey. Specifically: a. GARFO PRD and DOI (BOEM and BSEE) must be notified within 24 hours of any interaction with a sea turtle or sturgeon (nmfs.gar.incidental- take@noaa.gov and DOI via TIMSWeb and notification email at protectedspecies@bsee.gov). The report must include at a minimum 1) survey name and applicable information (e.g., vessel name, station number); 2) GPS coordinates describing the location of the interaction (in decimal degrees); 3) gear type involved (e.g., bottom trawl, longline); 4) soak time, gear configuration, and any other pertinent gear information; 5) time and date of the interaction; and 6) identification of the animal to the species level. Additionally, the email must transmit a copy of the NMFS Take Report Form (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null) and a link to or acknowledgement that a clear photograph or video of the animal was taken (multiple photographs are suggested, including at least one photograph of the head scutes). If reporting within 24 hours is not possible due to distance from shore or lack of ability to communicate via telephone, fax, or email, reports must be submitted as soon as possible; late reports must be submitted with an explanation for the delay. b. At the end of each survey season, a report must be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species. This report must also contain information on all survey activities that took place during the season including location of gear set, duration of soak/trawl, and total effort. The report on survey activities must be comprehensive of all activities, regardless of whether ESA-listed species were observed.	This measure would not modify the impact determination for finfish or EFH, but it would provide the information and reporting and enforcement mechanisms necessary to ensure that effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Monthly/ annual reporting requirements	BOEM and BSEE would ensure that Revolution Wind submits regular reports (in consultation with NMFS) necessary to document the amount or extent of take that occurs during all phases of the proposed action. Details of reporting must be coordinated between Revolution Wind, NMFS, BOEM, and BSEE. All reports would be sent to: nmfs.gar.incidental- take@noaa.gov and BSEE via TIMSWeb and notification email at protectedspecies@bsee.gov.	This measure would not modify the impact determination for finfish or EFH, but it would provide the information and reporting and enforcement mechanisms necessary to ensure that effects do not exceed the levels analyzed herein.
Scour and cable protection	To the extent technically and economically feasible, the Lessee must ensure that all materials used for scour and cable protection consist of natural or engineered stone that does not inhibit epibenthic growth. The materials selected for protective purposes should mirror the natural environment and provide similar habitat functions.	This measure would not modify the impact determination for finfish or EFH, but it would enhance the quality of artificial habitats created by the installation of scour and cable protection through the support of epibenthic growth and the addition of three-dimensional complexity in height and interstitial spaces.
Post-installation cable monitoring	Revolution Wind would be required to inspect all cables after construction is completed to document exact location, burial depth, and post-installation benthic habitat conditions. Inspections must be completed within 6 months of Project commissioning, annually for the first 3 years following construction and as needed following major storm events. Monitoring reports must be submitted to BOEM within 45 days of survey completion.	This measure would not modify the impact determination for finfish or EFH, but it would validate the location and burial depth of installed cables and allow for the timely identification of cables that become unburied and pose shallow hazard risks.
Atlantic cod spawning monitoring plan	At least 90 days prior to inter-array cable installation (e.g., boulder relocation, pre-cut trenching, cable crossing installation, cable lay and burial) and foundation site preparation (e.g., scour protection installation), BOEM would require the Lessee to provide DOI with a plan to monitor for Atlantic cod aggregations that are indicative of spawning behavior during the above-listed activities between November 1 and March 30 of each year (Plan). The objective of the Plan is to detect Atlantic cod aggregations and avoid or minimize the above-listed activities in any area with aggregations of Atlantic cod indicative of spawning behavior, as technically and economically feasible. The Lessee must include in the Plan details on detection thresholds (e.g., density and location) of spawning Atlantic cod aggregations that would trigger the adaptive	This measure would not modify the impact determination for finfish or EFH, but it would provide the information and a reporting and enforcement mechanism to ensure that construction impacts on spawning Atlantic cod do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	management of activities described in this paragraph, including any restrictions on activities in any area with aggregations of Atlantic cod indicative of spawning behavior, and analysis of technical and/or economic infeasibility.	
Periodic underwater surveys, reporting of monofilament and other fishing gear around WTG foundations	The Lessee must monitor potential loss of fishing gear near WTG foundations by surveying at least 10% of the total installed foundations annually. Revolution Wind must report the results of the surveys to BOEM (at renewable_reporting@boem.gov) and BSEE (at marinedebris@bsee.gov) in an annual report, submitted by April 30 for the preceding calendar year. Annual reports must be submitted in Microsoft Word format. Photographic and videographic materials must be provided on a portable drive in a lossless format such as TIFF or Motion JPEG 2000. Annual reports must include survey reports that include the survey date; contact information of the operator; the location and pile identification number; photographic and/or video documentation of the survey and debris encountered; any animals sighted; and the disposition of any located debris (i.e., removed or left in place). Required data and reports may be archived, analyzed, published, and disseminated by BOEM.	This measure would not modify the impact determination for finfish or EFH, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.
Sound field verification (SFV)	BOEM must require Revolution Wind to develop an SFV plan. The purpose of SFV is to document that modeled acoustic injury threshold distances and associated monitoring requirements are sufficiently protective for sensitive marine species. The SFV process must be sufficient to assess sound propagation from each foundation and attenuation distances to potential injury and behavioral effects thresholds for marine mammals, sea turtles, and fish. To validate the estimated sound field, SFV measurements must be conducted during pile driving of the first three monopiles installed over the course of the Project, with noise attenuation activated. A SFV plan must be submitted to NMFS, BOEM, USACE, and BSEE for review and approval preferably 180 days but no later than 120 days prior to planned start of pile driving. This plan must describe how	This measure would not modify the impact determination for finfish or EFH, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	Revolution Wind must ensure that the first three monopile installation sites selected for sound field are representative of the rest of the monopile installation sites and, in the case that they are not, how additional sites must be selected for SFV. This plan must also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS. The plan must describe how the effectiveness of the sound attenuation methodology must be evaluated based on the results. In the event that Revolution Wind obtains technical information that indicates a subsequent monopile is likely to produce larger sound fields, SFV must be conducted for those subsequent monopiles.	
Passive acoustic monitoring (PAM) plan	BOEM, BSEE, and USACE would ensure that Revolution Wind prepares a PAM plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the required use of PAM for monitoring. This plan must be submitted to NMFS, BOEM (at renewable_reporting@boem.gov), and BSEE (via TIMSWeb with a notification email at protectedspecies@bsee.gov) for review and concurrence preferably 180 days but no later than 120 days prior to the planned start of pile driving.	This measure would not modify the impact determination for construction noise effects on finfish or EFH but ensure that those effects remain within the levels described in this FEIS.
Passive acoustic monitoring, long-term	Use PAM buoys or autonomous PAM devices to record ambient noise, marine mammals, and cod vocalizations in the Lease Area before, during, and immediately after construction for up to 25 years of operation to monitor Project noise. The archival recorders must have a minimum capability of detecting and storing acoustic data on anthropogenic noise sources (such as vessel noise, pile driving, WTG operation, and whale detections), marine mammals, and cod vocalizations in the Lease Area. Monitoring would also occur during the decommissioning phase. The total number of PAM stations and array configuration will depend on the size of the zone to be monitored, the amount of noise expected in the area, and the characteristics of the signals being monitored to accomplish both monitoring during constructions, and also meet post-construction monitoring needs. Results must be provided within 90 days of construction completion and again within 90 days of the 1-year, 2-	This measure would not modify the impact determination for construction and operational noise effects on finfish or EFH but would improve understanding of these impacts on specific resources (e.g., Atlantic cod) and inform future management and mitigation measures.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	year, and 3-year anniversary of collection. The underwater acoustic monitoring must follow standardized measurement and processing methods and visualization metrics developed by the Atlantic Deepwater Ecosystem Observatory Network (ADEON) for the U.S. Mid- and South Atlantic OCS (see https://adeon.unh.edu/). At least two buoys must be independently deployed within or bordering the Lease Area or one or more buoys must be deployed in coordination with other acoustic monitoring efforts in the RI/MA and MA WEAs. As an alternative to conducting PAM in its project area, the lessee may opt to meet this monitoring requirement through an annual deposit to BOEM's Environmental Studies Program in support of its Partnership for an Offshore Wind Energy Regional Observation Network (POWERON) initiative. The lessee's contribution would cover activities within its lease area, such as the purchase of instruments, annual deployments and refurbishment, data processing, and long-term data archiving. Funding from BOEM, other partners, and potentially other lessees will support long-term PAM throughout the region which will enable broader-scale analyses on cumulative effects to marine species. Under this option, the lessee will be expected to cooperate with the POWERON team to facilitate deployment and retrieval of instruments within the project area. If necessary, the lessee may request temporary withholding of the public release of acoustic data that has been collected within its project area.	
Long-term PAM	Long-term monitoring of ambient noise, marine mammal, and cod vocalizations in the Lease Area before, during, and following construction. Continuous recording must occur at least 30 days prior to pile driving, during foundation pile driving, initial operation, and for at least 3 full calendar years of operation to monitor for potential impacts. At least three devices must be independently deployed within the lease area to maximize spatial coverage of the project area based on 10-kilometer spacing between deployment locations or as otherwise agreed between BOEM and the Lessee. The locations of the three buoys must be coordinated with the Regional Wildlife Science Collaborative prior to the plan being	This measure would not modify the impact determination for construction and operational noise effects on finfish or EFH but would improve understanding of these impacts on specific resources (e.g., Atlantic cod) and inform future management and mitigation measures.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	submitted to BOEM and BSEE. Devices may be moved to new locations during the recording period, if existing PAM devices will be present in the lease area providing continuous recording. The archival recorders must have a minimum capability of continuously detecting and storing acoustic data on vessel noise, pile-driving, WTG operation, baleen whale vocalizations, and cod vocalizations in the lease area. No later than 180 days prior to buoy deployment, the Lessee must submit to BOEM and BSEE (renewable_reporting@boem.gov and OSWsubmittals@bsee.gov) the PAM plan, which describes all proposed equipment, deployment locations, detection review methodology, and other procedures and protocols related to the required use of PAM for monitoring. The PAM plan must detail mooring best practices, data management, storage, measurement, and data processing best practices that are required by BOEM for long-term PAM monitoring. Refer to Regional Wildlife Science Collaborative for Offshore Wind Data Management & Storage Best Practices for Long-term and Archival Passive Acoustic Monitoring (PAM) Data. Other best practices consistent with COP approval should be detailed in the plan. The long-term PAM Plan must include the proposed equipment, sample rate, mooring design, deployment locations, methods for baleen whale and cod detections, and metrics for ambient noise analysis. The long-term PAM plan must be submitted to BOEM and BSEE (at renewable_reporting@boem.gov and OSWsubmittals@bsee.gov) for review and concurrence. BOEM and BSEE will review the long-term PAM Plan and provide comments, if any, on the plan within 45 calendar days, but no later than 90 days of its submittal. The plan must satisfy all outstanding comments to BOEM's and BSEE's satisfaction. The Lessee will receive written concurrence from DOI upon acceptance of the final long-term PAM plan. If DOI does not provide comments on the long-term PAM Plan within 90 calendar days of its submittal, the Lessee may conclusively presume DOI's concurrence with the long-term PAM Plan.	

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	Long-term PAM monitoring results must be provided within 180 days of buoy collection and again within 180 days of the annual anniversaries of each the PAM device deployments. All raw data must be sent to NCEI for archiving no later than 6 months following the date of each recorder recovery. As an alternative to conducting long-term PAM in its project area, the lessee may opt to meet this monitoring requirement through an annual deposit to BOEM's Environmental Studies Program in support of its Partnership for an Offshore Wind Energy Regional Observation Network (POWERON) initiative. The lessee's contribution would cover activities within the area of potential effect of the project, such as the purchase of instruments, annual deployments and refurbishment, data processing, and long-term data archiving. Funding from BOEM, other partners, and potentially other lessees will support long-term PAM throughout the region which will enable broader-scale analyses on cumulative effects to marine species. Under this option, the Lessee will be expected to cooperate with the POWERON team to facilitate deployment and retrieval of instruments within the project area. If necessary, the Lessee may request temporary withholding of the public release of acoustic data that has been collected within its project area. Record long-term measurements of ambient noise, marine mammal, and cod vocalizations in the Lease Area before, during, and following construction.	
Sound field verification (SFV)	NMFS, BOEM, BSEE, and USACE would ensure that if the clearance and/or shutdown zones are expanded, PSO coverage is sufficient to reliably monitor the expanded clearance and/or shutdown zones. Additional observers must be deployed on additional platforms for every 1,500 m that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification. To validate the estimated sound field, SFV measurements would be conducted during pile driving of the first three monopiles installed over the course of the Project, with noise attenuation activated. A SFV plan would be submitted to NMFS, BOEM, USACE, and BSEE for review and approval preferably 180 days but no later than 120 days	This measure would not modify the impact determination for construction noise effects on finfish or EFH but would provide a mechanism for ensuring that those impacts remain within levels considered in this FEIS.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	prior to planned start of pile driving. This plan would describe how Revolution Wind would ensure that the first three monopile installation sites selected for sound field are representative of the rest of the monopile installation sites and, in the case that they are not, how additional sites would be selected for SFV. This plan would also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS. The plan would describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. In the event that Revolution Wind obtains technical information that indicates a subsequent monopile is likely to produce larger sound fields, SFV would be conducted for those subsequent monopiles.	

* Information in these rows was taken directly from NMFS (2023) and has not been edited.

Table 3.13-14. Additional Mitigation and Monitoring Measures Under Consideration for Finfish and Essential Fish Habitat (Appendix F, Table F-3)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Boulder relocation plan	To minimize the number of potential seafloor obstructions that may interact with bottom trawl fisheries, the Lessee must submit to BOEM a boulder relocation plan that will include the following: 1) Identification of areas of active (within last 5 years) bottom trawl fishing, areas where boulders > 2 m in diameter are anticipated to occur, and areas where boulders are expected to be relocated for Project purposes 2) Methods to minimize the quantity of seafloor obstructions from relocated boulders in areas of active bottom trawl fishing, as identified in #1 The plan must be submitted to BOEM at least 90 days prior to inter-array cable corridor preparation and cable installation (e.g., boulder relocation, pre-cut trenching, cable crossing installation, cable lay and	This measure would not modify the impact determinations for finfish or EFH but would provide a process and information useful for monitoring impacts to EFH and sensitive species and their recovery.

Mitigation Measure	**Description**	**Expected Effect on Impacts from Action Alternatives**
	burial) and foundation site preparation (e.g., scour protection installation).	
Post-installation cable monitoring	Revolution Wind must provide BOEM with a cable monitoring report following each IAC and export cable inspection to determine cable location, burial depths, state of the cable, and site conditions. An inspection of the IAC and export cable is expected to include high-resolution geophysical (HRG) methods, such as a multi-beam bathymetric survey equipment, and is expected to identify seafloor features, natural and human-made hazards, and site conditions along federal sections of the cable routing. In federal waters, the initial IAC and export cable inspection would be carried out within 6 months of commissioning, and subsequent inspections would be carried out at years 1, 2, and every 3 thereafter and after a major storm event. Major storm events are defined as when metocean conditions at the facility meet or exceed the 1 in 50-year return period calculated in the metocean design basis, to be submitted to BOEM with the facility design report (FDR). If conditions warrant adjustment to the frequency of inspections following the Year 2 survey, a revised monitoring plan may be provided to BOEM for review. In addition to inspection, the export cable would be monitored continuously with the as-built Distributed Temperature Sensing System. If distributed temperature sensing data indicate that burial conditions have deteriorated or changed significantly and remedial actions are warranted, the distributed temperature sensing data, a seafloor stability analysis, and report of remedial actions taken or scheduled must be provided to BOEM within 45 calendar days of the observations. The Distributed Temperature Sensing data, cable monitoring survey data, and cable conditions analysis for each year must be provided to BOEM as part of the annual compliance reports, required by 30 CFR 285.633(b).	This measure would not modify the impact determinations for finfish or EFH but would provide a process to ensure that impacts to these resources are limited to the levels considered in this Final EIS.
Anchoring plan	BOEM requires Revolution Wind to develop an anchoring plan to ensure anchoring is avoided and minimized in complex habitats, archaeological	This measure requires that anchoring plan implementation covers O&M and decommissioning

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	resources, and UXOs during Project construction and all O&M activities throughout the operational life of the Project. The anchoring plan is required to be provided for review and comment prior to BOEM approval.	activities. It would not modify the impact determination for finfish or EFH, but it would help to ensure that long-term impacts to large-grained complex and complex habitats and benthic habitat structure are effectively minimized.

3.13.2.10.1 Measures Incorporated into the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.13-13 and Table F-2 in Appendix F (Mitigation and Monitoring) are incorporated into Alternative G (Preferred Alternative). As specified in Table 3.13-13, BOEM is considering the reasonable and prudent measures (RPMs) and terms and conditions (T&Cs) identified in the draft NMFS Biological Opinion to avoid and minimize take of ESA-listed Atlantic sturgeon. These measures are described in Appendix F, Table F-2. BOEM will require compliance with the negotiated RPMs and T&Cs in the final Biological Opinion to be issued on July 21, 2023. Implementation of the mitigation measures in Table 3.13-13 would ensure the effectiveness of, and compliance with, the EPMs analyzed as part of the Proposed Action. This would ensure that impacts to finfish and EFH are limited to the levels described in this Final EIS. In addition, as stated in Table 3.13-13, BOEM is considering the conservation recommendations identified by NMFS in the EFH determination letter for the Project dated June 16, 2023 (NMFS, NOAA, GARFO 2023). These measures, detailed in Table F-2 in Appendix F, would: further avoid and minimize impacts to large-grained complex and complex habitat, with emphasis on habitats used by Atlantic cod for spawning; impose additional timing restrictions to avoid and minimize construction impacts on Atlantic cod; and eliminate or substantially reroute components of the RWF and RWEC to avoid and minimize impacts to sensitive habitats in the Lease Area and the RWEC-RI corridor.

BOEM has also identified additional measures in Table 13.13-14. These measures, if adopted, would have the effect of reducing the magnitude and extent of impacts to large-grained complex and complex habitats used by EFH species within the RWEC and RWF, minimize the potential for construction-related activities (i.e., pile driving during monopile installation and IAC installation and foundation site preparation activities) to disturb Atlantic cod spawning aggregations, and provide valuable information that could inform future management and mitigation measures.

3.14 Land Use and Coastal Infrastructure

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to land use and coastal infrastructure from implementation of the Proposed Action and other considered alternatives.

3.15 Marine Mammals

3.15.1 Description of the Affected Environment for Marine Mammals

This section evaluates marine mammal resources within the GAA. Because the GAA is extensive (224,314,908 acres, Figure 3.15-1), the analysis focuses on marine mammals that would likely occur in and near the proposed RWF and RWEC on an at least infrequent basis and could be impacted by Project activities. The impact levels used to describe effects on marine mammals are defined in Tables 3.3-2 and 3.3-3 in Section 3.3. This impact terminology differs from the effect determinations used by NMFS in ESA Section 7 consultation and the take terminology used for Marine Mammal Protection Act (MMPA) compliance; therefore, the impact levels presented in the BA (BOEM 2023a, 2023b) and ITA for the Project, if issued by NMFS, will differ.

Geographic analysis area: The intent of the GAAs used in this EIS is to define a reasonable boundary for assessing the potential effects, including cumulative effects, resulting from the development of an offshore wind energy industry on the Mid-Atlantic OCS. GAAs for marine biological resources are necessarily large because marine populations range broadly and cumulative impacts can be expressed over broad areas. GAAs are not used as a basis for analyzing the effects of the Proposed Action, which represent a subset of these broader effects and are expressed over a smaller area. These impacts are analyzed specific to each IPF.

The GAA for marine mammals comprises the Scotian Shelf, Northeast Shelf, and Southeast Shelf Large Marine Ecosystems, as shown in Figure 3.15-1. This area encompasses the migratory range of marine mammal populations that could occur within or near the RWF and RWEC during the construction and installation, O&M, and decommissioning of the Project.

Affected environment: A diverse marine mammal community inhabits the Northwest Atlantic OCS region (the region). Twenty-seven species, comprising six baleen whale species; 18 species of toothed whales, dolphins, and porpoises; two species of seals; and the West Indian manatee (*Trichechus manatus*), could occur, or are known to occur, in the region (BOEM 2014; CSA Ocean Sciences Inc. 2023). All these species are protected under the federal MMPA, and five are listed as endangered under the ESA. One species, West Indian manatee, is listed as threatened under the ESA. Of the six marine mammals listed under the ESA, critical habitat has been designated for only NARW and West Indian manatee. Manatee occurrence in the RWF and RWEC, while conceivable, is unlikely.

Table 3.15-1 identifies species known or expected to occur in the region and their likelihood and timing of occurrence in the RWF and RWEC. COP Appendix Z1 (CSA Ocean Associates 2023) provides detailed species descriptions and life history information for all marine mammal species likely to occur in the GAA. NOAA has summarized the most current information about marine mammal population status, occurrence, and use of the region in their 2021 final and 2022 draft stock assessment reports for the Atlantic OCS and Gulf of Mexico (Hayes et al. 2022, 2023).

The EIS analysis focuses on 18 marine mammal species that are known to regularly occur in and around the RWF and RFEC. Several of these species are highly migratory and only occur seasonally, some are present year-round, and some could be present year-round but display distinct seasonal peaks. The ESA-listed species expected to occur are NARW (*Eubalaena glacialis*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*) (Davis et al. 2020; Kraus et al. 2016; NEFSC and Southeast Fisheries Science Center [SEFSC] 2018). Several other marine mammal species could occur in the general vicinity, including the ESA-listed blue whale (*Balaenoptera musculus*), which is known to occur in the region but primarily in waters along the edge of the OCS that are at least 75 miles from the proposed RWF and RWEC. Species occurrence on the OCS and likelihood of occurrence in the RWF and RWEC maximum work area are summarized in Table 3.15-1 (the maximum work area is shown in Figure 2.1-1). Table 3.15-2 provides a summary of the current status and population trends for marine mammal species that are expected to be exposed to the effects of the alternatives considered herein and the effect of baseline environmental stressors on each population. The impact analyses presented herein consider the incremental impacts of each alternative above and beyond existing conditions.

BOEM acknowledges the Mashpee Wampanoag Tribe's reverence for the NARW and has given careful consideration to the potential impacts to NARWs throughout development of the EIS. BOEM is also consulting with NMFS under the ESA and would require compliance with all mitigation and reporting measures in the NMFS biological opinion if the COP were approved or approved with modification.

Construction and operational noise are IPFs of particular concern. Thus, consistent with NOAA (2018) guidance, marine mammals have been organized into different hearing groups for the purpose of evaluating underwater noise impacts based on how they hear and their sensitivity to different types of noise. Low-frequency cetaceans (LFCs) considered in this analysis comprise baleen whales in the order *Mysticeti* (also referred to as mystecetes). This group includes NARW and other baleen whales with hearing sensitivity and communication concentrated in low-frequency bands from 7 Hz to 35 kHz. Mid-frequency cetaceans (MFCs) considered in this analysis include dolphins and other toothed whales in the order *Odontoceti* (also referred to as odontocetes). The hearing sensitivity of this group is concentrated in the 150-Hz to 160-kHz range. High-frequency cetaceans (HFCs) comprise the true porpoises, such as harbor porpoise, and other odontocetes with hearing sensitivity concentrated in the 275-Hz to 160-kHz range. Phocid pinnipeds (i.e., earless/true seals) hear in the 50-Hz to 86-kHz range. BOEM is relying on the current NOAA guidance to assess underwater noise impacts but recognizes that marine mammal hearing is an evolving science. Improved understanding (e.g., Southall et al. 2019) could lead to future refinements of species-specific hearing ranges and sound sensitivity thresholds. An overview of underwater noise impacts on marine mammals is provided in Appendix G.

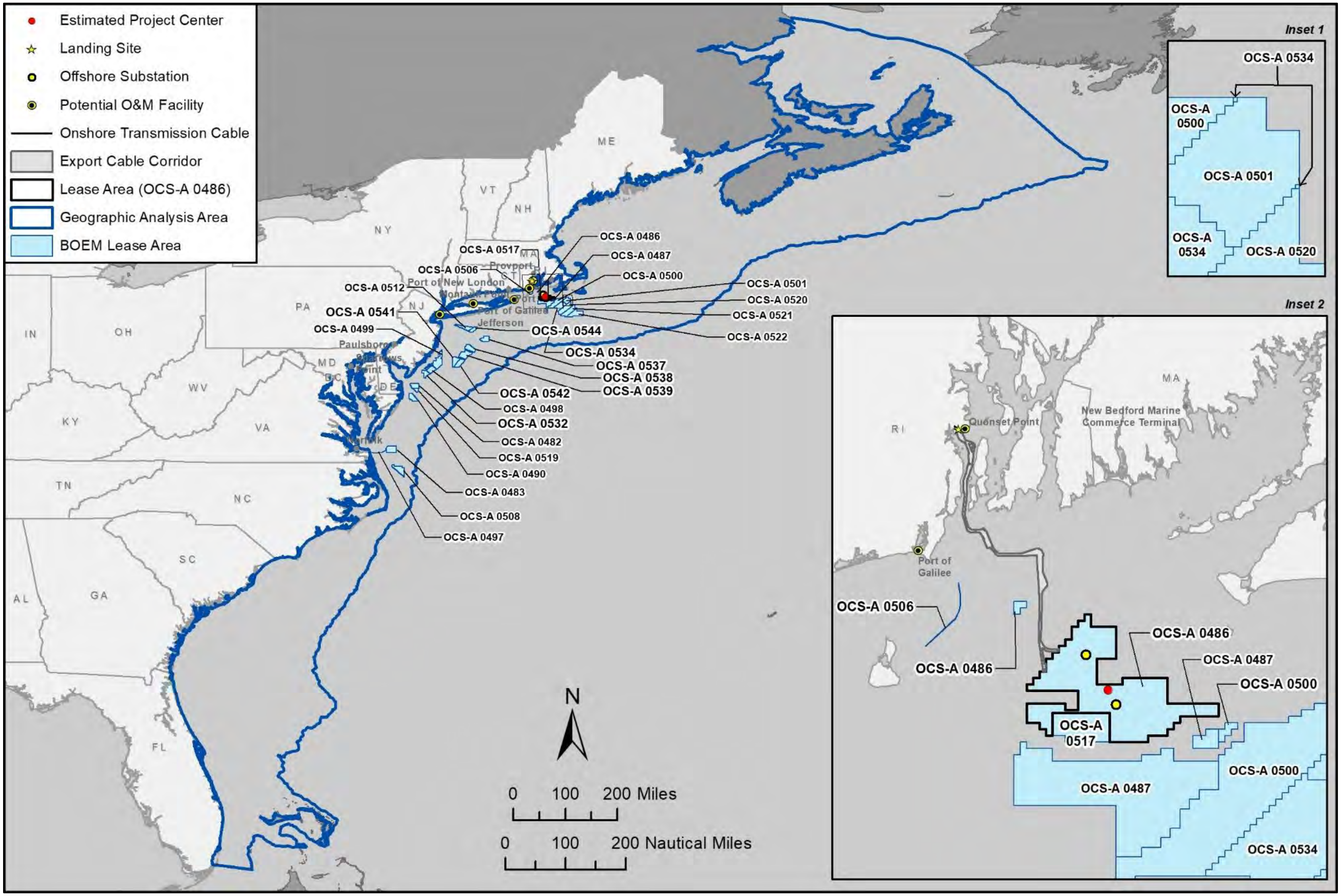

Figure 3.15-1. Geographic analysis area for marine mammals.

Table 3.15-1. Frequency of Marine Mammal Species Occurrence in Northwest Atlantic Outer Continental Shelf and Likelihood of Occurrence in the Revolution Wind Farm and Revolution Wind Farm Export Cable Corridor

Common Name	Scientific Name	ESA/MMPA Status*,†	Occurrence in Northwest Atlantic OCS‡	Annual (peak) Occurrence§	Species Occurs in RWF and RWEC‡,§,¶,#	Critical Habitat Occurs in the RWF and RWEC**
Baleen Whales – Suborder Mysticeti, Family Balaenopteridae						
NARW	*Eubalaena glacialis*	E/D	Common	YR (W-Sp)	Yes	No
Blue whale	*Balaenoptera musculus*	E/D	Uncommon	YR (W-Sp)	Yes	Not yet designated
Sei whale	*B. borealis*	E/D	Uncommon	YR (Sp)	Yes	Not yet designated
Fin whale	*B. physalus*	E/D	Common	YR	Yes	Not yet designated
Minke whale	*B. acutorostrata*	None/N	Common	YR (Su-F)	Yes	Not applicable (N/A)
Humpback whale	*Megaptera novaeanglia*	None/N	Common	YR (W-Sp)	Yes	N/A
Toothed Whales – Suborder Odontoceti, Family Physeteridae						
Sperm whale	*Physeter macrocephalus*	E/D	Common	YR (Su-F)	Yes	N/A
Toothed Whales – Family Kogiidae						
Dwarf sperm whale	*Kogia sima*	None/N	Rare	Su	No	N/A
Pygmy sperm whale	*K. breviceps*	None/S	Not expected	Su	No	N/A
Toothed Whales – Family Ziphiidae						
Blainville's beaked whale	*Mesoplodon densirostris*	None/S	Not expected	YR	No	N/A
Cuvier's beaked whale	*Ziphius cavirostris*	None/S	Rare	YR	No	N/A
Gervais' beaked whale	*M. europaeus*	None/S	Not expected	YR	No	N/A
Sowerby's beaked whale	*M. bidens*	None/S	Not expected	YR	No	N/A
True's beaked whale	*M. mirus*	None/S	Not expected	YR	No	N/A
Toothed Whales – Family Delphinidae						
Risso's dolphin	*Grampus griseus*	None/N	Common§	YR (Sp-F)	Yes	N/A
Long-finned pilot whale	*Globicephala melas*	None/S	Common§	YR (Sp-Su)	Yes	N/A
Short-finned pilot whale	*Globicephala macrorhynchus*	None/N	Rare‡	YR (Sp-Su)	No	N/A
White-beaked dolphin	*Lagenorhynchus albirostris*	None/N	Regular (north of Cape Cod)§	Sp	No	N/A
Atlantic white-sided dolphin	*L. acutus*	None/N	Regular§	YR (Sp-F)	Yes	N/A
Atlantic spotted dolphin	*Stenella frontalis*	None/N	Uncommon	Sp-F	No	N/A
Striped dolphin	*S. coeruleoalba*	None/N	Rare‡,§	YR	No	N/A
Short-beaked common dolphin	*Delphinus delphis*	None/N	Common	YR (Su-F)	Yes	N/A
Bottlenose dolphin	*Tursiops truncatus*	None/D††	Rare	YR	Yes	N/A

Common Name	Scientific Name	ESA/MMPA Status*,†	Occurrence in Northwest Atlantic OCS‡	Annual (peak) Occurrence§	Species Occurs in RWF and RWEC‡,§,¶,#	Critical Habitat Occurs in the RWF and RWEC**
Toothed Whales – Family Phococenidae						
Harbor porpoise	*Phocoena phocoena*	None/N	Common	YR (F-Sp)	Yes	N/A
Earless Seals – Order Carnivora, Suborder Caniformia, Family Phocidae						
Harbor seal	*Phoca vitulina concolor*	None/N	Regular	YR (F-Sp)	Yes	N/A
Gray seal	*Halichoerus grypus*	None/N	Regular	YR	Yes	N/A
Order Sirenia						
West Indian manatee	*Trichechus manatus*	Threatened/S	Not expected#	Unknown	No	No

Source: BOEM (2014); Curtice et al. (2018); Hayes et al. (2020, 2021, 2022); Kraus et al. (2016); NEFSC and SEFSC (2018); O'Brien et al. (2021a, 2021b); Quintana et al. (2019); Roberts et al. (2021).

Note: Species that do not occur in the RWF and RWEC are unexpected to be affected by the Project and are not considered further in this EIS.

* ESA status: E = Endangered.

† MMPA status: S = Strategic; N = Not Strategic; D = Depleted.

‡ Data from LGL (2022). Common = occurring consistently in moderate to large numbers; regular = occurring in low to moderate numbers on regular basis or seasonally; uncommon = occurring in low numbers or on regular basis; rare = records for some years but limited; not expected = range includes the RWF and RWEC corridor, but due to habitat preferences and distribution info, species are not expected to occur.

§ Data from NEFSC and SEFSC (2018) and Davis et al. (2020). YR = year-round; W = winter; Sp = spring; Su = summer; F = fall.

¶ Data from Kraus et al. (2016); O'Brien et al. (2021a, 2021b); Quintana et al. (2019).

Data from CSA Ocean Sciences Inc. (2023).

** Construction vessels traveling to the analysis area could conceivably travel through NARW critical habitat (81 *Federal Register* 4838). However, specific ports of origin and travel routes are not currently known and will be determined by the Project contractor.

†† There are two stocks of bottlenose dolphins identified in the area. The Northern Migratory Coastal stock is depleted. The Atlantic offshore stock is not depleted.

Table 3.15-2. Population Status, Trend, and Effect of Human-Caused Mortality on Marine Mammal Species Likely to Occur in the Revolution Wind Farm and Revolution Wind Farm Export Cable

Marine Mammal Hearing Group*	Common Name	Scientific Name	Stock	Population Estimate†	Population Trend‡	Annual Human-Caused Mortality§	Effect of U.S. Human-Caused Mortality¶	Baseline Impact DeterminationΔ	Reference Source
Mysticetes - low-frequency cetaceans (LFC)	NARW#	*Eubalaena glacialis*	Western North Atlantic	2019–2020: 339-723 2020–2021: 336–368 2022: 338	Decreasing	8.15	Significant	Major adverse	Pettis et al. (2021); Hayes et al. (2022); Hayes et al. (2023)
	Blue whale	*Balaenoptera musculus*	Western North Atlantic	402	Unavailable	Unknown	Unknown	Minor adverse	Hayes et al. (2022)
	Fin whale#	*B. physalus*	Western North Atlantic	6,802	Unavailable	2.35	Significant	Moderate adverse	Hayes et al. (2022)
	Sei whale#	*B. borealis*	Nova Scotia	6,292	Unavailable	1.2	Significant	Moderate adverse	Hayes et al. (2022)
	Minke whale	*B. acutorostrata*	Canadian East Coast	21,968	Unavailable	10.55	Insignificant	Minor adverse	Hayes et al. (2022)
	Humpback whale	*Megaptera novaeanglia*	Gulf of Maine	1,393	+2.8%/year	15.25	Significant	Minor adverse	Hayes et al. (2022)

Marine Mammal Hearing Group*	Common Name	Scientific Name	Stock	Population Estimate†	Population Trend‡	Annual Human-Caused Mortality§	Effect of U.S. Human-Caused Mortality¶	Baseline Impact DeterminationΔ	Reference Source
Odontocetes - mid-frequency cetaceans (MFC)	Sperm whale¶	*Physeter macrocephalus*	North Atlantic	4,349	Unavailable	Unknown	Unknown	Moderate adverse	Hayes et al. (2022)
	Risso's dolphin	*Grampus griseus*	Western North Atlantic	35,215	Unavailable	53.9	Significant	Moderate adverse	Hayes et al. (2022)
	Long-finned pilot whale	*Globicephala melas*	Western North Atlantic	39,215	Unavailable	21	Insignificant	Minor adverse	Hayes et al. (2022)
	Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic	28,924	Unavailable	Unknown	Insignificant	Minor adverse	Hayes et al. (2022)
	Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	93,233	Unavailable	26	Insignificant	Minor adverse	Hayes et al. (2022)
	Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	39,921	Decreasing	0	Insignificant	Minor adverse	Hayes et al. (2022)
	Short-beaked common dolphin	*Delphinus delphis*	Western North Atlantic	172,974	Unavailable	399	Significant	Moderate adverse	Hayes et al. (2022)
	Bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic - Offshore	62,851	Unavailable	28	Insignificant	Minor adverse	Hayes et al. (2022)
			Western North Atlantic – Northern Coastal Migratory	6,639	Decreasing	12.2 to 21.5	Insignificant	Minor adverse	Hayes et al. (2022)
Odontocetes - high-frequency cetaceans (HFC)	Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	95,543	Unavailable	150	Significant	Moderate adverse	Hayes et al. (2022)
Phocid pinnipeds (Phocids)	Harbor seal	*Phoca vitulina concolor*	Western North Atlantic	61,336	Unavailable	365	Significant	Moderate adverse	Hayes et al. (2022)
	Gray seal	*Halichoerus grypus*	Western North Atlantic (U.S. population)	27,300	Increasing	953	Significant	Minor adverse	Hayes et al. (2022)

* Marine mammal hearing groups defined by NOAA (2018).

† Most recently available stock size estimate, per cited reference.

‡ Increasing = beneficial trend, not quantified; Decreasing = adverse trend, not quantified; Unavailable = population trend analysis not conducted on this species.

§ Based on annual human-caused mortality as a percentage of potential biological removal (PBR): Significant = > 10% of PBR; Insignificant = < 10% of PBR. Statistic based on fishing-related mortality with inferred contribution from other sources (e.g., vessel collisions).

Δ Impact determination for the effect of existing environmental conditions on the identified marine mammal population applying the impact criteria defined in Section 3.2. This determination considers the projected impacts of human-caused mortality and other factors, including climate change, on the population in the absence of each alternative considered in this EIS. In the case of NARW, the population is in severe decline, and human-caused mortality is known to be a significant contributor to population status; therefore, the impact of the baseline conditions is major. For other species, if human-caused mortality is insignificant as a percentage of PBR, BOEM concludes the impact of baseline conditions is minor. If human-caused mortality is significant and the population is decreasing in abundance or abundance is unknown, BOEM considers the impact of the baseline condition to be moderate. If the population is increasing in abundance, BOEM considers the impact of human activities on baseline conditions to be minor.

¶ Reflects human-caused mortality from all known sources, including fishing-related, vessel collisions, and other/unspecified. Per cited reference.

Species is ESA listed.

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3.15.2 Environmental Consequences

3.15.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

The analysis presented in this section considers the impacts resulting from the maximum-case scenario under the PDE approach developed by BOEM to support offshore wind project development (Rowe et al. 2017). The maximum design size specifications defined in Appendix D, Table D-1, are PDE parameters used to conduct this analysis. Several Project parameters could change during the development of the final Project configuration, potentially reducing the extent and/or intensity of impacts resulting from the associated IPFs.

The Project design parameters in Table 3.15-3 would result in reduced impacts relative to those generated by the design elements considered under the PDE.

Table 3.15-3. Project Design Parameters That Could Reduce Impacts

Parameter	Description
The permitting and installation of fewer WTGs	This would result in fewer offshore structures and reduced IAC cable length. This would reduce the extent of short-term to permanent impacts on marine mammals by reducing the extent and duration of underwater noise impacts from WTG foundation installation, and reducing the extent of reef and hydrodynamic effects resulting from structure presence.
The Project could use a casing pipe method to construct the RWEC sea-to-shore transition	This would result in less acoustic impact than vibratory pile driving to construct a cofferdam (Zeddies 2021).
The use of a temporary cofferdam for RWEC sea-to-shore transition construction	This would reduce suspended sediment effects on marine mammals.

IPFs that are either not applicable to the resource or determined by BOEM to have a negligible adverse effect are excluded from Chapter 3 and provided in Appendix E2, Table E2-5. Where feasible, calculations for specific alternative impacts are provided in Appendix E, Attachment E4, to facilitate reader comparison across alternatives.

Table 3.15-4 summarizes the IPFs and impact findings carried forward for analysis in this section. Each alternative analysis considers impacts resulting from the construction and installation phase, the O&M phase, and the decommissioning phase of the Project, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion. This comparison considers implementation of all EPMs proposed by Revolution Wind to avoid and minimize adverse impacts to marine mammals. These EPMs are summarized in Appendix F, Table F-1.

A detailed analysis of the impacts of the Proposed Action on marine mammals is provided in the following section. The impact analyses presented for the other action alternatives focus only on those IPFs that would differ measurably in extent, duration, and/or magnitude between alternatives, resulting in substantially different impacts on marine mammals when compared to the Proposed Action. Offshore and onshore IPFs are addressed separately as appropriate for each resource; not all IPFs have both an offshore and onshore component. For marine mammals, onshore Project activities would not result in impacts to marine resources. Therefore, onshore impacts would have no measurable effects on relevant habitats or species and are not evaluated below.

The Conclusion section for each alternative analysis provides a rationale for each effect determination. The overall effect determination for each alternative is **moderate** adverse for marine mammals.

Table 3.15-4. Alternative Comparison Summary for Marine Mammals

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
Anchoring and new cable emplacement/ maintenance	**Offshore**: Under the No Action Alternative, BOEM would not approve the COP. Various stressors associated with the construction, operations, and maintenance of the Project would not occur, and there would be no incremental impact to environmental baseline conditions from this IPF. Anchoring or mooring activities and cable installation from construction of other approved wind energy projects (SFWF and Vineyard Wind) could result in seafloor disturbance and suspended sediment impacts within the GAA for marine mammals. Only larger construction and O&M vessels would anchor to the seafloor, using large heavy anchor chains. No lines or rigging are anticipated for cable installation, and transmission cables and jet plow umbilicals are large in diameter, relatively inflexible, and under constant tension, resulting in limited risk for entanglement. While suspended sediment impacts would vary in extent and intensity depending on project and site-specific conditions, measurable impacts are likely to be on the order of 500 mg/L or lower, lasting for minutes to hours, and limited in extent to within a few feet vertically and a few hundred feet horizontally from the point of disturbance. The resulting effects of anchoring and cable emplacement on marine mammals would likely be **negligible** to **minor** adverse because of the temporary and localized nature of the impacts.	**Offshore**: Anchoring and cable emplacement effects could lead to short-term adverse effects on invertebrate and finfish prey species. However, these impacts are not likely to significantly affect the availability of prey and forage resources for any marine mammal species. Therefore, anchoring and cable emplacement during construction would have **negligible** adverse effects on marine mammals. Effects to marine mammals from cable O&M and decommissioning and O&M vessel anchoring would be similar in nature but lesser in scale and magnitude than those resulting from Project construction. As such, seafloor disturbance impacts would have **negligible** adverse effects on marine mammals. Vessel anchoring and cable emplacement during construction, O&M, and decommissioning are not anticipated to involve equipment, lines, or rigging that could pose a potential entanglement risk to marine mammals. Therefore, the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in **negligible** to **minor** adverse cumulative effects on marine mammals.	**Offshore**: Alternatives C through F would result in the installation of a reduced total length of IAC and a reduced extent of anchoring impacts relative to the Proposed Action. This would proportionally reduce the extent of construction-related impacts on marine mammals. Consistent with the Proposed Action, anchoring and cable emplacement during construction, O&M, and decommissioning would have **negligible** adverse effects on marine mammals for the duration of the construction activities. While suspended sediment impacts would vary in extent and intensity depending on Project and site-specific conditions, measurable impacts are likely to be on the order of 500 mg/L or lower, lasting for minutes to hours, and limited in extent to within a few feet vertically and a few hundred feet horizontally from the point of disturbance. No population-level effects on marine mammals are expected from reduced water quality. Therefore, Alternatives C through F when combined with past, present, and reasonably foreseeable activities would result in **negligible** to **minor** adverse cumulative effects on marine mammals.				**Offshore**: Similar to Alternatives C through F, Alternative G would result in the installation of a reduced total length of IAC and a reduced extent of anchoring impacts relative to the Proposed Action. This would proportionally reduce the extent of construction-related impacts on marine mammals. Consistent with the Proposed Action, anchoring and cable emplacement during construction, O&M, and decommissioning would have **negligible** adverse effects on marine mammals for the duration of the construction activities. Although suspended sediment impacts would vary in extent and intensity depending on Project and site-specific conditions, measurable impacts are likely to be on the order of 500 mg/L or lower, lasting for minutes to hours, and limited in extent to within a few feet vertically and a few hundred feet horizontally from the point of disturbance. No population-level effects on marine mammals are expected from reduced water quality. Therefore, Alternatives G when combined with past, present, and reasonably foreseeable activities would result in **negligible** to **minor** adverse cumulative effects on marine mammals.
Climate change	**Offshore**: The nature and potential significance of climate change effects to marine mammals are unknown but likely to range from **minor** to **moderate** adverse. Effects to individual species, such as NARW, would depend on a number of complex factors, including the nature and extent of climate change impacts on the availability and distribution of forage and	**Offshore**: The Proposed Action in combination with existing and planned future actions would result in the development of a network of artificial reefs distributed across the GAA. The biological hotspots created by these artificial reefs are expected to influence fish and invertebrate community structure at local scales and could also influence the ability of certain fish and invertebrate species to shift and expand their	**Offshore**: Climate change–related impacts to marine mammals under Alternatives C through F would be similar to those described for the Proposed Action. Ongoing trends associated with climate change, including increases in water temperature, ocean acidification, changes in runoff and circulation patterns, and species range shifts, are expected to continue. The intensity of climate change impacts on marine mammals is uncertain but likely to range from **minor** to **moderate** adverse. Effects to individual species, such as NARW, would depend on a number of complex factors, including the nature and extent of climate change impacts on the availability and distribution of forage and suitable habitat, the ability of the species to adapt to these impacts, and the status and resilience of the affected population.				**Offshore**: Similar to Alternatives C through F, climate change–related impacts to marine mammals under Alternative G would be similar to the Proposed Action, i.e., uncertain but likely to range from **minor** to **moderate** adverse. Effects to individual species, such as NARW, would depend on a number of complex factors, including the nature and extent of climate change impacts on the availability and

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	suitable habitat, the ability of the species to adapt to these impacts, and the status and resilience of the affected population.	ranges in response to climate change. This could in turn result in cumulative effects on marine mammals that could be beneficial or adverse depending on a number of complex factors. The nature and potential significance of these effects to marine mammals are unknown but likely to range from **minor** to **moderate** adverse. Effects to individual species, such as NARW, would depend on a number of complex factors, including the nature and extent of climate change impacts on the availability and distribution of forage and suitable habitat, the ability of the species to adapt to these impacts, and the status and resilience of the affected population.					distribution of forage and suitable habitat, the ability of the species to adapt to these impacts, and the status and resilience of the affected population.
Noise	**Offshore**: Under the No Action Alternative, BOEM would not approve the COP. Various stressors associated with the construction, operations, and maintenance of the Project would not occur, and there would be no incremental impact to environmental baseline conditions from this IPF. Sound sources such as impact pile driving, construction vessels, and HRG survey noise associated with other offshore wind energy development could adversely affect marine mammals. All approved offshore wind actions are expected to include EPMs to avoid and minimize impacts on marine mammals. When these factors are considered, the effects of noise exposure on marine mammals under the No Action Alternative would range from **minor** to **moderate** adverse. Effects to specific marine mammal species are uncertain and would depend on the number of individuals exposed to injury and behavioral-level noise effects, the significance of those effects to survival and reproductive productivity, and the status and sensitivity of the affected population to effects to individuals. Noise and disturbance effects on marine mammals from aircraft operations under the No Action Alternative are expected to be **negligible** adverse because of	**Offshore**: Construction of the RWF and RWEC would produce short-term underwater and airborne noise with the potential to affect marine mammals. Overall, underwater noise during impact pile-driving activities would have a **minor** to **moderate** adverse effect on marine mammals, depending on the species. Noise impacts from construction would result in **minor** impacts to marine mammals in the MFC, HFC, and phocid pinniped hearing groups, and **minor** to **moderate** impacts to marine mammals in the LFC hearing group. NARW and humpback whale could experience **moderate** impacts based on the proportion of the stock exposed to potential behavioral effects, and in the case of NARW, greater sensitivity to those effects. The indirect effect of this underwater noise on marine mammals through impacts to prey species would be short term and **negligible** adverse due to the availability of prey resources for marine mammals on the OCS. Likewise, airborne pile-driving noise would be **negligible** adverse because of established EPMs and likely avoidance response. While some individual marine mammals could experience short-term behavioral and auditory effects from vessel noise exposure, these effects would be short term in duration and broader stock or population-level impacts would be unlikely. Therefore, construction vessel noise impacts on marine mammals would likely be **minor** adverse. Noise and disturbance effects on	**Offshore**: See Section 3.15.2.3.1 for construction impacts. Operational noise impacts under Alternatives C through F would be similar to those described for the Proposed Action (**negligible** to **moderate** adverse) but reduced in extent. See Section 3.15.2.4 for a comparison of pile-driving noise impacts amongst the alternatives. Offshore WTGs produce continuous non-impulsive underwater noise during operations, mostly in lower frequency bands below 8 kHz. The low-frequency sounds produced by WTGs are within the range of hearing sensitivity and audible communication frequencies used by many species of marine mammals (NOAA 2018), indicating that this impact mechanism could be a potential source of behavioral and auditory masking effects on marine mammal species. However, the maximum predicted operational noise level would attenuate below the behavioral harassment threshold for marine mammals within 120 feet of each turbine foundation, suggesting that behavioral and masking effects would occur within a small radius around each turbine. Impacts to marine mammals in the LFC hearing group, including NARW, that use or attempt to use habitats in the RWF could rise to **moderate** adverse. In contrast, operational noise impacts on phocid pinnipeds are likely to be negligible to minor because these species are not as dependent on sound for communication. Vessels used for Project monitoring, comparable to vessels typical for trawl fisheries, would produce noise, but the noise levels generated by these smaller Project vessels are below the hearing injury threshold of marine mammals; therefore, vessel noise from Project monitoring activities is not expected to result in injury-level effects. The associated disturbance from decommissioning would be similar to construction, with the exception that pile driving would not be required. Monopiles would be cut below the bed surface with equipment-producing noise levels generally indistinguishable from engine noise (Pangerc et al. 2016). Due to the higher capacity of the turbines, there is potential for greater operational noise impacts around each individual turbine for Alternative F, although specifics of these impacts are not certain. Effects from Alternatives C through F would combine with similar effects resulting from the construction and installation, O&M, and decommissioning of other planned offshore wind projects on the Mid-Atlantic OCS. Up to 3,146 to 3,183 new offshore structures associated with offshore wind development would be installed on the GAA under these alternatives. The installation of these structures would likely involve impact pile driving, an intense source of underwater noise with the potential to impact marine mammals. Alternatives C through F				**Offshore**: See Section 3.15.2.3.1 for construction impacts. Similar to Alternatives C through F, operational noise impacts under Alternative G would be similar in magnitude and by hearing group to those from the Proposed Action (**negligible** to **moderate** adverse) but reduced in extent. See Section 3.15.2.4 for a comparison of pile-driving noise impacts amongst the alternatives. Effects from Alternative G would combine with similar effects resulting from the construction and installation, O&M, and decommissioning of other planned offshore wind projects on the Mid-Atlantic OCS. Up to 3,155 new offshore structures associated with offshore wind development would be installed on the GAA under Alternative G. The installation of these structures would likely involve impact pile driving, an intense source of underwater noise with the potential to impact marine mammals. Alternative G would contribute an appreciable increase in underwater noise due to the installation of 65 foundations. HRG surveys, vessel engines, and operational noise from the WTGs would also contribute non-impulsive noise that could result in behavioral effects or displacement of marine mammals. On this basis, cumulative adverse effects on marine mammals resulting from underwater noise are likely to be **minor** to **moderate** adverse, with impacts by species group similar to but likely

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	protective regulations and temporary nature of the impacts.	marine mammals from aircraft operations are also expected to be **minor** adverse because of protective regulations and the temporary nature of the impact. Offshore WTGs produce continuous non-impulsive underwater noise during operations, mostly in lower frequency bands below 8 kHz. This localized, long-term impact would constitute a **moderate** adverse effect on marine mammals belonging to the low-frequency cetacean hearing group, including NARW. Operational noise effects on marine mammals in other hearing groups would be **minor** adverse because of the lack of overlap with the frequencies used for hearing and communication. Noise levels generated by the larger SOVs would be similar to those for Project construction vessels and would result in short-term **minor** adverse noise effects that would occur periodically throughout the life of the Project. Noise effects from vessels associated with monitoring efforts and decommissioning would result in **negligible** adverse impacts to marine mammals because any exposure would be limited in duration and similar to baseline noise levels generated by existing vessel traffic. BOEM anticipates that future MMPA approvals would consider the known status of individual marine mammal stocks and populations, indirectly incorporating the potential combined effects of future projects. Therefore, BOEM concludes that the cumulative effects of construction noise on marine mammals would be **moderate** adverse because of the potential for PTS impact to some species, and temporary threshold shift (TTS) and behavioral effect exposure to other species during construction activities. While the potential for broader effects is unclear BOEM concludes that the cumulative effects of low-level operational noise could rise to the level of **minor** adverse for certain marine mammal species.	would contribute an appreciable increase in underwater noise due to the installation of up to 93 foundations. HRG surveys, vessel engines, and operational noise from the WTGs would also contribute non-impulsive noise that could result in behavioral effects or displacement of marine mammals. On this basis, cumulative adverse effects on marine mammals resulting from underwater noise are likely to be **minor** to **moderate** adverse. As with the Proposed Action, effects to specific marine mammal species are uncertain and would depend on the number of individuals exposed to injury and behavioral-level noise effects, the significance of those effects to survival and reproductive productivity, and the status and sensitivity of the affected population to effects to individuals.				less extensive than those resulting from the Proposed Action.
Presence of structures	**Offshore** Under the No Action Alternative, BOEM would not approve the COP. Various stressors associated with	**Offshore**: Effects on marine mammals from installation of WTG and OSS foundations construction would result primarily from underwater noise impacts related to impact pile	**Offshore**: Installation of structures for Alternatives C through F would result in similar impacts on marine mammals to those described for the Proposed Action in Section 3.15.2.2.1, but those impacts would be reduced in extent and would vary depending on the configuration selected (refer to Table 3.6-18 for configuration details). Indirect effects on the prey base of				**Offshore**: Similar to Alternatives C through F, installation of structures for Alternative G would result in similar impacts on marine mammals to those described for the Proposed

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative D (Transit Alternative) 78 to 93 WTGs	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	the construction, operations, and maintenance of the Project would not occur, and there would be no incremental impact to environmental baseline conditions from this IPF. Other ongoing offshore wind projects (SFWF and Vineyard Wind) would add new WTG and OSS foundations in the GAA would result in artificial reef and hydrodynamic effects that influence primary and secondary productivity and the distribution and abundance of fish and invertebrate community structure within and in proximity to project footprints. The effect of these effects on marine mammals and their habitats could be beneficial or adverse, potentially ranging from **minor** adverse to **negligible** to **moderate** beneficial. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including species-specific displacement effects, the nature and extent of effects to forage resources, and the status of the affected population and sensitivity to effects to individuals. However, the potential interaction with fishing gear and increased risk of entanglement is considered to have a **minor** to **moderate** adverse effect on marine mammals because of the documented significance of entanglement events. In the case of NARW, continuation of baseline conditions is likely to pose a serious risk to the species based on its imperiled status.	driving and noise disturbance from associated vessel activity. Ongoing effects from the presence of structures would result from operational noise, described above, and biological and oceanographic effects resulting from the physical presence of structures. RWF monopile foundations would be placed in a grid-like pattern with spacing of approximately 1.0 (0.9 to 1.1) nm between turbines. This spacing relative to animal size indicates that the physical presence of the monopile foundations is unlikely to pose a barrier to the movement of large marine mammals, and even less likely to impede the movement of smaller marine mammals. On this basis, BOEM concludes that the presence of the RWF monopile foundations would pose a **negligible** adverse risk of displacement effects on marine mammals. However, long-term reef and hydrodynamic effects resulting from the Proposed Action could result in **minor** beneficial effects on fish-eating marine mammals such as dolphins and seals that benefit from increased prey abundance around the structures and **negligible** adverse effects on marine mammals that forage on plankton and forage fish, including NARW. Habitat conditions would be expected to revert back to those that existed prior to installation. Therefore, the effects of the presence of structures on marine mammals during decommissioning would be **negligible** adverse because the structures themselves would be removed from the habitat. Several projects would be constructed concurrently, potentially resulting in individual marine mammals being exposed to multiple episodes of habitat displacement. It is anticipated that these projects would also employ a similar range of EPMs to avoid and minimize impacts to marine mammals, but some level of short-term displacement is likely to occur, and some individual animals are likely to be exposed to multiple episodes of displacement. The significance of these potential impacts is unclear, but when all protective measures are considered, cumulative effects are likely to range from **minor** to **moderate** adverse. Impacts to specific species, such as NARW, are uncertain and would depend	some marine mammal species (i.e., invertebrates and finfish) from the presence of structures would occur, but these would primarily be limited to long-term effects considered under the O&M and Decommissioning discussion in Section 3.15.2.2.2. Construction and installation of offshore structures would have temporary, **negligible** to **minor** adverse effects on marine mammals. Impacts to specific marine mammal species for Alternatives C through F would reduce the number of offshore wind energy structures. These structures would result in similar impacts on marine mammals to those described for the Proposed Action in Section 3.15.2.2.2, but those impacts would be reduced in extent. Over the life of the Project, the structures would alter the character of the ocean environment, and their presence could affect marine mammal behavior; however, the likelihood and significance of these effects are difficult to determine. Indirectly, marine mammals could benefit from increased prey abundance around the structures due to long-term reef and hydrodynamic effects. However, these effects would only benefit fish-eating species; effects to marine mammals that forage on plankton and forage fish would be **negligible** adverse. The increase in fish biomass could also result in an elevated risk of entanglement and interaction with commercial and recreational fishing gear, although the implementation of EPMs related to management of debris surrounding the WTGs (see Table F-1 in Appendix F) is expected to limit the risk. Following decommissioning and removal of the structures from the water column, the habitat would be expected to recover to conditions similar to those in the surrounding environment. Therefore, impacts of the presence of structures on marine mammals are expected to be **negligible** adverse to **minor** beneficial for the life of the Project. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including species-specific displacement effects, the nature and extent of effects to forage resources, and the status of the affected population and sensitivity to effects to individuals. BOEM estimates that up to 3,146 to 3,183 new WTG and OSS foundations would be added in the GAA under other planned future projects, in addition to 56 to 93 WTG and two OSS foundations proposed under various configurations for Alternatives C through F. The long-term presence of WTG and OSS structures could displace marine mammals from preferred habitats or alter movement patterns, potentially changing exposure to commercial and recreational fishing activity. Addition of these foundations would also result in artificial reef and hydrodynamic effects that influence primary and secondary productivity and the distribution and abundance of fish and invertebrate community structure within and in proximity to project footprints. These effects could indirectly influence marine mammals by altering the distribution and abundance of prey species. Increased fish biomass around the structures could also attract commercial and recreational fishing activity, leading to increased risk of entanglement and interaction with fishing gear. However, BOEM anticipates that future projects would perform regular inspections to identify and remove derelict (i.e., "ghost") fishing gear and other marine debris from offshore structures, thereby reducing the associated risk to marine mammals. The cumulative effects of long-term habitat alteration and hydrodynamic impacts on marine mammals are unclear, could be positive or negative, could range from **negligible** to **moderate** adverse. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including species-specific displacement effects, the nature and extent of effects to forage resources, and the status of the affected population and sensitivity to effects to individuals. There is currently no reasonable scientific basis to conclude that these impact mechanisms would result in greater than **moderate** adverse effects on any marine mammal species.				Action in Section 3.15.2.2.1: temporary, **negligible** to **minor** adverse effects on marine mammals. Effects to specific species, such as NARW, would depend on the same factors described for the Proposed Action. Likewise, when combined with past, present, and reasonably foreseeable activities, Alternative G would result in similar but reduced impacts on marine mammals to those described for the Proposed Action in Section 3.15.2.2.2. Over the life of the Project, the structures would alter the character of the ocean environment, and their presence could affect marine mammal behavior; however, the likelihood and significance of these effects are difficult to determine. Indirectly, marine mammals could benefit from increased prey abundance around the structures due to long-term reef and hydrodynamic effects. However, these effects would only benefit fish-eating species; effects to marine mammals that forage on plankton and forage fish would be **negligible** adverse. The increase in fish biomass could also result in an elevated risk of entanglement and interaction with commercial and recreational fishing gear, although the implementation of EPMs related to management of debris surrounding the WTGs (see Table F-1 in Appendix F) is expected to limit the risk. Following decommissioning and removal of the structures from the water column, the habitat would be expected to recover to conditions similar to those in the surrounding environment. Therefore, impacts from the presence of structures on marine mammals are expected to be **negligible** adverse to **minor** beneficial for the life of the Project. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including species-specific displacement effects, the nature and extent of effects to forage resources, and the status of the affected population and sensitivity to effects to individuals. BOEM estimates that up to 3,155 new WTG and OSS foundations would be added in the GAA under other planned future projects, in

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		on several factors, including species-specific displacement effects, the nature and extent of effects to forage resources, and the status of the affected population and sensitivity to effects to individuals. In addition to effects from displacement alone, displacement resulting in increased interactions between vulnerable populations of marine mammals and commercial shipping and/or fishing activity could, in theory, have significant long-term cumulative effects. However, the potential for displacement and level of effects are uncertain and unknown, and there is currently no basis to conclude that these impacts would result in greater than **minor** adverse long-term effects on any species. The cumulative effects of long-term habitat alteration and hydrodynamic impacts on marine mammals are unclear, could be beneficial or adverse, could range from **negligible** to **moderate** adverse. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including the nature and extent of effects to forage resources, the significance of these effects to individual survival and reproductive fitness, and the status of the affected population and sensitivity to effects to individuals.					addition 65 WTGs within 79 possible WTG locations and two OSS foundations proposed under various configurations for Alternative G. The long-term presence of WTG and OSS structures could displace marine mammals from preferred habitats or alter movement patterns, potentially changing exposure to commercial and recreational fishing activity. Addition of these foundations would also result in artificial reef and hydrodynamic effects that influence primary and secondary productivity and the distribution and abundance of fish and invertebrate community structure within and in proximity to project footprints. These effects could indirectly influence marine mammals by altering the distribution and abundance of prey species. Increased fish biomass around the structures could also attract commercial and recreational fishing activity, leading to increased risk of entanglement and interaction with fishing gear. However, BOEM anticipates that future projects would perform regular inspections to identify and remove derelict (i.e., "ghost") fishing gear and other marine debris from offshore structures, thereby reducing the associated risk to marine mammals. The cumulative effects of long-term habitat alteration and hydrodynamic impacts on marine mammals are unclear, could be positive or negative, could range from **negligible** to **moderate** adverse, with effects to specific species dependent on the same factors described for the Proposed Action. There is currently no reasonable scientific basis to conclude that these impact mechanisms would result in greater than **moderate** adverse effects on any marine mammal species.
Vessel traffic	**Offshore**: Under the No Action Alternative, BOEM would not approve the COP. Various stressors associated with the construction, operations, and maintenance of the Project would not occur, and there would be no incremental impact to environmental baseline conditions from this IPF. Vessel activity	**Offshore**: Because vessel strikes are not an anticipated outcome given the relatively low number of vessel trips and EPMs to avoid encountering marine mammals, BOEM concludes vessel strikes are unlikely to occur. Therefore, there is no anticipated effect on marine mammals and collision effects would be **negligible** adverse during Project construction. However, vessel	**Offshore**: Construction of Alternatives C through F would result in similar vessel traffic impacts on marine mammals to those described for the Proposed Action, but the total number and distribution of vessel trips would be reduced by varying amounts depending on the configuration selected. Vessel traffic associated with the RWF would be expected to increase less than the 2.1% per year across transects 13-17 (Figure 3.15-2) estimated for the Proposed Action. Therefore, collision-related effects would be **negligible** adverse during Project construction. The presence of construction vessels and associated noise and disturbance could cause short-term displacement of marine mammals from preferred habitats. Vessel				**Offshore**: Similar to Alternatives C through F, construction of Alternative G would result in similar vessel traffic impacts on marine mammals to those described for the Proposed Action, but the total number and distribution of vessel trips would be reduced. Therefore, collision-related effects would be **negligible** adverse during Project construction. Vessel

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	from other offshore wind projects is estimated to peak in 2025 with as many as 210 vessels involved in the construction of reasonably foreseeable projects. BOEM anticipates that traffic risks would be minimized by project-specific EPMs and compliance with additional measures required as a condition of ESA and MMPA compliance. Accordingly, effects to marine mammals from increased vessel activity could range from **minor** to **moderate** adverse.	displacement effects on marine mammals could range in significance from **minor** to **moderate** adverse depending on the species affected and the biological significance of displacement. Effects of vessel traffic on marine mammals from Project O&M and decommissioning would be **negligible** to **minor** adverse because of limited exposure and implemented EPMs. BOEM estimates that up to 262 construction vessels could be active within the GAA between 2022 and 2030. BOEM anticipates that all future projects would adhere to all mandatory and voluntary vessel speed restrictions in posted dynamic management areas (DMAs) and seasonal management areas (SMAs) (collectively Slow Zones) and would implement additional EPMs and measures similar to those described for the Proposed Action during construction and throughout the operational life of the Project to avoid marine mammal collisions. Therefore, the cumulative effects of increased vessel traffic on marine mammals would range from **negligible** to **moderate** adverse.	displacement effects on marine mammals could range in significance from **minor** to **moderate** adverse depending on the species affected and the biological significance of displacement, recognizing that some portion of these effects is also likely the result of construction noise, as described above. O&M and decommissioning of Alternatives C through F would result in similar vessel traffic impacts on marine mammals to those described for the Proposed Action, but those impacts would be reduced in extent. For the Proposed Action, Revolution Wind (Tech Environmental 2023) has estimated that Project O&M would involve up to four CTV and two SOV trips per month for wind farm O&M, or 2,280 vessel trips over the life of the Project. It can be assumed that Alternatives C through F would require similar or slightly fewer vessel trips during O&M. O&M vessel use would represent a minimal increase in regional vessel traffic over the life of the Project, and as detailed in Appendix F, all survey vessels would comply with speed restrictions and other minimization measures to minimize risk of collision with marine mammals, making the risk of vessel strikes from Project monitoring vessels unlikely. Consistent with the Proposed Action, adverse effects on marine mammals from vessel collisions or displacement would be **negligible** to **minor** adverse for the life of the Project through decommissioning. As described for the Proposed Action, BOEM anticipates that all future projects would adhere to all mandatory and voluntary vessel speed restrictions in posted DMAs and SMAs (collectively Slow Zones) and would implement additional EPMs and measures similar to those described for the Proposed Action during construction and throughout the operational life of the Project to avoid marine mammal collisions. Therefore, the cumulative effects of increased vessel traffic on marine mammals would range from **negligible** to **moderate** adverse.				displacement effects on marine mammals could range in significance from **minor** to **moderate** adverse depending on the species affected and the biological significance of displacement, recognizing that some portion of these effects is also likely the result of construction noise, as described above. O&M and decommissioning of Alternative G would result in similar vessel traffic impacts on marine mammals to the Proposed Action, but those impacts would be reduced in extent. Consistent with the Proposed Action, adverse effects on marine mammals from vessel collisions or displacement would be **negligible** to **minor** adverse for the life of the Project through decommissioning. As described for the Proposed Action, BOEM anticipates that all future projects would adhere to all mandatory and voluntary vessel speed restrictions in posted DMAs and SMAs (collectively Slow Zones) and would implement additional EPMs and measures similar to those described for the Proposed Action during construction and throughout the operational life of the Project to avoid marine mammal collisions. Therefore, the cumulative effects of increased vessel traffic on marine mammals would range from **negligible** to **moderate** adverse.

3.15.2.2 Alternative A: Impacts of the No Action Alternative on Marine Mammals

3.15.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, BOEM would not approve Revolution Wind's COP and the Project would not be constructed. Given this, stressors from construction, operation, and maintenance of the Project would not occur. Baseline conditions of the existing environment and their impacts on marine mammals, the impacts of which are summarized in Table 3.15-2, would remain unchanged. Therefore, not approving the COP would have no additional incremental effect on marine mammals. Similarly, NMFS's No Action Alternative (i.e., not issuing the requested incidental take authorization) would also have no additional incremental impact on marine mammals and their habitat. Baseline conditions for marine mammals (see Section 3.15.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the geographic analysis area. IPFs and effects from the development of these planned and permitted offshore wind activities are described and analyzed in Appendix E1.

3.15.2.2.2 Cumulative Impacts

This section discloses potential impacts to marine mammals associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (in the absence of the Proposed Action), is provided in Appendix E1. Cumulative impacts to marine mammals under the No Action Alternative would be incremental to and would compound the impacts of baseline conditions on each marine mammal population considered in this EIS (see Table 3.15-2).

Analysis of impacts presented below are for IPFs with the potential to produce greater than negligible effects. IPFs expected to produce negligible effects to marine mammals are addressed in Appendix E1, Table E2-5.

IPF effects from Project decommissioning are discussed where practicable, recognizing that Project decommissioning has not yet been developed and certain impacts cannot be quantified. All wind farm operators would be required to develop and submit a project-specific decommissioning plan to BOEM. Those plans would be subject to independent environmental and regulatory review and approval before decommissioning can proceed. Those reviews would consider the effects of facility removal on all marine biological resources relative to the environmental baseline conditions present at that time.

Offshore Activities and Facilities

<u>Anchoring and new cable emplacement/maintenance:</u> Anchoring or mooring activities from construction of future wind energy projects could result in seafloor disturbance and suspended sediment impacts within the GAA for marine mammals. It is estimated that 210 construction vessels would result in 8,427 acres of anchoring disturbance during the peak period of construction. Anchoring and mooring of these vessels would have limited adverse effects to marine mammals due to the temporary nature and relatively small area of the impact. Anticipated impacts from increased vessel traffic are discussed in full in the Vessel Traffic IPF below. Entanglement risks to marine mammals from vessel anchoring and cable emplacement are not anticipated. Only larger construction and O&M vessels would anchor to the seafloor, using large heavy anchor chains. No lines or rigging are anticipated for cable installation, and transmission cables and

jet plow umbilicals are large in diameter, relatively inflexible, and under constant tension. The likelihood of marine mammal entanglement under these conditions is discountable.

Future offshore wind projects could disturb up to 101,381 acres of seafloor while installing associated undersea cables, causing an increase in suspended sediment (see Appendix E, Attachment E4 for calculation details). Those effects would be similar in nature to those observed during construction of the BIWF (Elliot et al. 2017). While suspended sediment impacts would vary in extent and intensity depending on project and site-specific conditions, measurable impacts are likely to be on the order of 500 mg/L or lower, lasting for minutes to hours, and limited in extent to within a few feet vertically and a few hundred feet horizontally from the point of disturbance. Due to the temporary and localized nature of the impacts, the resulting effects of anchoring and cable emplacement on marine mammals would likely be **negligible** to **minor** adverse.

Climate change: Global climate change is an ongoing risk to marine mammals. Hayes et al. (2021, 2022) note that marine mammals are being forced to adapt to changes in the spatial distribution and abundance of their primary prey resources. The range of habitats for many finfish, invertebrate, and zooplankton species on the Mid-Atlantic OCS are shifting northward and toward deeper waters in response to changes in temperature regime, acidification, and other climate-driven effects on the ocean environment. The potential implications of these and other related environmental changes for marine mammals, and the ways in which they are likely to interact with the effects of regional offshore wind development, are complex and uncertain. This is particularly true when evaluating potential effects at the scale of the GAA. However, it is likely that some species would adapt to these environmental changes more effectively than others. In contrast, populations that are already vulnerable, such as NARW, could face increased risk of extinction as a consequence of climate change and other factors. The nature and potential significance of these effects to marine mammal are uncertain but likely range from **minor** to **moderate** adverse. Effects to individual species, such as NARW, would depend on a number of complex factors, including the nature and extent of climate change impacts on the availability and distribution of forage and suitable habitat, the ability of the species to adapt to these impacts, and the status and resilience of the affected population.

Noise: Numerous proposed offshore wind projects could be developed on the Mid-Atlantic OCS between 2022 to 2030 (see Appendix E). BOEM recently completed a programmatic ESA consultation for HRG survey activities supporting planned offshore wind energy development on the Mid-Atlantic OCS from June 2021 through June 2031. In addition to project-specific EPMs, BOEM would require compliance with all conditions of ESA and MMPA compliance and other federal regulations. That process is likely to result in additional measures to avoid and minimize adverse noise effects on marine mammals resulting from the various potential exposure scenarios described below.

Two types of underwater noise are considered in this assessment, impulsive and non-impulsive. Impulsive noise sources produce intermittent, short-duration, high-intensity sound pulses in rapid succession, and include sources like impact pile driving, HRG surveys, and UXO detonations. Non-impulsive sound sources are typically of lower intensity but are effectively continuous and include sources such as vibratory pile driving, construction and O&M vessel use, and WTG operations. Based on the anticipated extent of noise impacts, it is reasonable to conclude that sound sources such as impact pile driving, construction vessels, and HRG survey noise associated with offshore wind energy development could adversely affect marine mammals. In addition, construction noise impacts from future offshore projects could affect marine mammal use of the GAA and/or the availability of fish and invertebrate prey resources.

Impulsive Noise: The installation of up to 3,088 new offshore wind structures on the GAA under the No Action Alternative would likely involve impact pile driving, an intense source of underwater noise with the potential to impact marine mammals. Preconstruction HRG surveys conducted for these projects would also generate impulsive noise of lower intensity that is less likely to injure marine mammals but could alter their behavior. Other potential sources of impulsive noise include use of a pneumatic hammers (e.g., for landfall construction) and UXO detonation. The potential duration and extent of underwater noise effects on marine mammals from these sound sources are described below.

The planned construction of up to 3,088 new offshore wind structures would begin in 2022 and continue through 2030. Many of these structures would be installed using impact pile driving, producing high-intensity impulsive underwater noise at levels exceeding injury and behavioral harassment thresholds for marine mammals. These noise impacts could affect marine mammal use of the GAA, and/or the availability of fish and invertebrate prey resources and would vary in extent and intensity based on the scale and design of each project. Noise effects could increase in significance if individual marine mammals and/or their prey and forage resources experience repeated stressor exposures from multiple projects.

Marine mammals could experience any of the following three potential exposure scenarios under the No Action Alternative:

- Concurrent exposure to noise from two or more impact hammers, operating within the same project or in adjacent projects
- Non-concurrent exposure to noise from multiple pile-driving events within the same year
- Exposure to two or more concurrent or non-concurrent pile-driving events over multiple years

Based on currently planned project schedules, the concurrent exposure scenario could occur under the No Action Alternative. The number of potential concurrent exposure days within the RI/MA and MA WEAs, for example, is estimated to range from 76 to 441, assuming one foundation installation per project per day, and from 38 to 221 days assuming two foundations per project per day, depending on the year (based on active projects listed in Table E3-1 in Appendix E3). Behavioral avoidance of noise impacts could also indirectly affect marine mammal use of the area, even if significant impacts do not occur therein. An individual marine mammal present in either of these areas on those days could be exposed to the noise from more than one pile-driving event per day.

Concurrent pile driving within and between future projects would increase the intensity and extent of sound exposure within the respective impact areas but would decrease the total number of days of stressor exposure in any given year. It may be desirable to plan for concurrent pile driving to avoid underwater noise impacts during critical periods when sensitive or particularly vulnerable populations (e.g., NARW) are most likely to be present. However, this could result in greater exposure for marine mammal species that are more likely to be present when concurrent pile driving occurs. These individuals could be more likely to suffer noise-related permanent threshold shift (PTS) impacts and other adverse physiological and behavioral effects as a consequence. Physiological effects could include elevated chronic stress and depressed immune function (Erbe et al. 2018; Romano et al. 2004; Wright et al. 2007).

Under the non-concurrent exposure scenario, individual marine mammals could be exposed to multiple non-concurrent pile-driving activities at different times within the same year. This scenario includes concurrent neighboring projects that time their respective pile-driving activities to occur on different days. Non-concurrent pile driving would decrease the intensity and extent of impulsive noise exposure but would increase the total number of exposure days. Given that multiple future actions are proposed for construction between 2022 and 2030 (see Table E3-1 in Appendix E3), it is likely that some individual marine mammals would experience two or more impact pile-driving noise exposure days within the same year.

UXO detonation may be necessary prior to ground-breaking activities for future offshore wind projects if devices are identified that cannot be avoided or safely relocated. The potential number, size, and distribution of UXOs within the GAA is not currently known and would be assessed during preconstruction surveys. Although the shock pulse and pressure waveforms of explosive detonation is significant and distinct from impact pile driving, use of attenuation methods such as bubble curtains is expected to be effective at minimizing effects (Bellman et al. 2020, Hannay and Zykov 2022). Potential effects of UXO detonations would be fully assessed for each future proposed project, based on site-specific information.

HRG surveys would also produce mobile impulsive underwater noise. BOEM (2021a) reviewed underwater noise levels produced by the available types of HRG survey equipment as part of a programmatic biological assessment for this and other activities associated with regional offshore wind energy development. NMFS (2021) concurred with BOEM's determination that planned HRG survey activities using even the loudest available equipment types would be unlikely to injure or measurably affect the behavior of ESA-listed marine mammals. The rationale supporting this conclusion also applies to non-listed marine mammal species. Specifically, the noise levels produced by HRG survey equipment are relatively low, meaning that an individual marine mammal would have to remain close to the sound source for extended periods of time to experience PTS injury. This type of exposure is unlikely as the sound sources are continuously mobile and some sources are directional (i.e., pointed at the bottom). These measures would effectively avoid the risk of PTS (i.e., hearing injury) or TTS (i.e., temporary hearing impairment) effects on marine mammals from HRG survey activities. While individual marine mammals could be exposed to HRG survey noise sufficient to cause behavioral effects, those effects would be temporary in nature and unlikely to cause any perceptible longer-term consequences to individuals or populations.

Under the No Action Alternative, it is likely that underwater noise impacts sufficient to cause adverse effects on marine mammals could occur. This could result from direct noise impacts that adversely affect marine mammals and/or their prey species, or from behavioral effects that alter marine mammal use of the area. The extent, duration, and significance of these effects would vary based on project-specific factors. All future actions are expected to include EPMs to avoid and minimize impacts on marine mammals. When these factors are considered, the effects of impulsive noise exposure on marine mammals under the No Action Alternative would range from **minor** to **moderate** adverse because of the anticipated noise from pile driving. Impacts to specific species, such as NARW, would depend on the number of individuals exposed to injury and/or behavioral level effects and the status of the affected population.

Non-impulsive Noise: The construction and O&M of planned future wind projects would generate non-impulsive underwater noise from vibratory pile driving during construction, helicopters and fixed-wing aircraft noise, construction and O&M vessel engines, and operational noise from WTGs. Horizontal directional drilling proposed at the landfall site also has the potential to produce non-impulsive noise; however, analysis of noise produced by such methods suggest that levels would be low, especially compared to other activities occurring in the same location (Nedwell et al. 2012). These new sources of non-impulsive noise sources under the No Action Alternative would add to other human-made sources of non-impulsive noise that account for the majority of ambient noise pollution in the marine environment. Continuous low-frequency sound from large vessel engines, specifically ocean-going cargo, tanker, and container vessels, is the primary source of ambient noise pollution in the marine environment (Basset et al. 2012). While smaller vessels, activities such as vibratory pile driving, and offshore wind farm operations also generate non-impulsive noise, these sources are likely to account for a small percentage of ambient noise energy in the marine environment.

Construction vessels associated with planned offshore wind projects are the most likely sources of non-impulsive underwater noise impacts to occur in the GAA. Vibratory pile-driving noise from the installation of cofferdams as part of cable installation for future projects could also occur in the GAA. Non-impulsive noise impacts on marine mammals resulting from these activities would vary in location, extent, and duration, as determined by the specific design and construction requirements for each project. The resulting effects on marine mammals would similarly range from **minor** to **moderate** adverse, varying by marine mammal species.

Tougaard et al. (2020) summarized available monitoring data on wind farm operational noise, including both older generation geared turbine designs and quieter modern direct-drive systems such as those proposed for the RWF. Underwater sound pressure level (L_{rms} or SPL) measurements taken approximately 50 to 200 m from operating turbines were generally in the range of 115 to 125 dB re 1 μPa, in the 10-Hz to 8-kHz bandwidth at a reference distance of 164 feet (50 meters). This is consistent with the L_{rms} observations at the BIWF (110 to 125 dB re 1 μPa at 50 meters) (Elliot et al. 2019) and the range of values observed at European wind farms and is therefore representative of the range of operational noise levels likely to occur from future wind energy projects. More recently, Stober and Thomsen (2021) used monitoring data and modeling to estimate operational noise from larger (10 MW) current generation direct-drive WTGs and concluded that these designs could generate higher operational noise levels than those reported in earlier research. This suggests that operational noise effects on marine mammals could be more intense and extensive than those considered herein, but additional research is needed. Operational noise from offshore wind turbines on the order of 115 to 120 dB re 1 μPa at 164 feet (50 meters) would attenuate below the 120 dB re 1 μPa marine mammal behavioral harassment threshold (NMFS 2019) within approximately 35 to 165 feet of each foundation. Kraus et al. (2016) measured ambient noise conditions at three locations within and adjacent to the proposed RWF over a 3-year period and identified baseline levels of 102 to 110 dB re 1 μPa.[42] Operational noise of 115 to 120 dB re 1 μPa at 164 feet would attenuate below existing ambient noise levels within a few hundred to approximately 1,200 feet of each foundation as estimated using the cylindrical spreading model (University of Rhode Island 2021). This indicates that operational noise effects from other future actions would likely be **minor** adverse for the duration of operations because of the limited spatial extent of impacts, although uncertainty regarding operational noise effects associated with larger WTGs warrants continued attention to this issue.

[42] These are 50th and 90th percentile values for monitoring locations RI-1, RI-2, and RI-3, as reported by Kraus et al. (2016).

O&M vessels travelling through the GAA would generate underwater noise that would likely be measurable and detectable by marine mammals, but the effects would be temporary and localized. Impacts on individuals and/or their habitat would not lead to population-level effects. On this basis, the effects of underwater noise from future O&M vessel activities would likely be **minor** adverse and temporary (i.e., during vessel transit).

Planned future actions could also employ helicopters and fixed-wing aircraft for initial site surveys, establishing and monitoring protected species shutdown zones during project construction, for periodic facility inspections during project O&M, and for crew transfers. Aircraft performing these activities in the GAA could travel close to and affect marine mammals. In general, marine mammal behavioral responses to aircraft most commonly occur at distances of less than 1,000 feet, and those responses are typically limited and likely insignificant (Patenaude et al. 2002). Similarly, aircraft could disturb hauled-out seals if aircraft overflights occur within 2,000 feet of a haul-out area. BOEM would require all aircraft operations to comply with current approach regulations for any sighted NARWs or unidentified large whale. Current regulations (50 CFR 224.103I) prohibit aircraft from approaching within 1,500 feet of NARW. BOEM expects that most aircraft operations would occur above this altitude limit except under specific circumstances (e.g., helicopter landings on the service operations vessel or visual inspections of WTGs). Aircraft operations could result in temporary behavioral responses, including short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002), but BOEM does not expect that these brief and infrequent exposures would result in measurable adverse effects on any marine mammal. On this basis, noise and disturbance effects on marine mammals from aircraft operations under the No Action Alternative are expected to be **negligible** adverse because of the protective regulations and temporary nature of the impacts.

Presence of structures: The future addition of up to 3,088 new WTG and OSS foundations in the GAA would result in artificial reef and hydrodynamic effects that influence primary and secondary productivity and the distribution and abundance of fish and invertebrate community structure within and in proximity to project footprints. Depending on proximity and extent, hydrodynamic and reef effects from future actions could influence the availability of prey and forage resources for marine mammals. Project-specific effects would vary, recognizing that larger and/or contiguous projects could have more significant hydrodynamic effects and broader scales. This could in turn lead to more significant effects on prey and forage resources.

A growing body of research has demonstrated that offshore wind farms could have observable effects on oceanographic conditions up to tens of miles downfield from wind farm sites (e.g., Christiansen et al. [2022]; Daewel et al. n.d. [2023]; Dorrell et al. [2022]; Floeter et al. [2022]; Raghukumar et al. [2022]), although the extent of these effects and resulting significance on biological processes are likely to vary considerably between different oceanographic environments (van Berkel et al. 2020). Van Berkel et al. (2020) and Schultze et al. (2020) note that environments characterized by strong seasonal stratification, such as the Mid-Atlantic Bight, are likely to be less sensitive to changes and disruptions to oceanographic processes from wind farm effects.

BOEM has conducted a modeling study to predict how planned offshore wind development in the RI/MA and MA WEAs could affect hydrodynamic conditions in the northern Mid-Atlantic Bight. Johnson et al. (2021) considered a range of development scenarios, including a large-scale build-out with a total of 1,063 WTG and OSS foundations. They determined that all scenarios would lead to small but measurable changes in current speed, wave height, and sediment transport in the northern Mid-Atlantic Bight. In addition, small changes in stratification could occur, leading to prolonged retention of cold water near the seafloor within the WEAs during spring and summer. Johnson et al. (2021) used an agent-based model to determine how hydrodynamic effects could influence the dispersal patterns of planktonic organisms. They determined that hydrodynamic effects are likely to alter the dispersal patterns of planktonic eggs and larvae, producing localized increases and decreases in larval density at scales ranging from miles to tens of miles. It is reasonable to conclude that hydrodynamic effects could influence the distribution of zooplankton and associated forage fish preyed upon by marine mammals at similar scales. When considered relative to the broader oceanographic factors that determine primary and secondary productivity in the region and seasonal and interannual variability, such localized impacts on zooplankton and fish abundance and distribution are not likely to be biologically significant for marine mammals. In theory, long-term changes in prey distribution on the order of tens of miles could contribute to displacement effects and increased interaction with fisheries; however, the likelihood and potential significance of such effects is unknown. Refer to Sections 3.6.1.1.1 and 3.13.1.1.1 for discussions of reef and hydrodynamic effects on invertebrates and finfish, respectively, from future offshore wind activities.

The long-term presence of WTG structures could displace marine mammals from preferred habitats or alter movement patterns, potentially changing exposure to commercial and recreational fishing activity. The evidence for long-term displacement is unclear and likely to differ between marine mammal species. For example, Long (2017) studied marine mammal habitat use around an ocean energy testing facility and found evidence of displacement during construction, but habitat use appeared to return to normal during facility operation. He cautioned that these findings were not definitive and additional research was needed. In contrast, Tielmann and Carstensen (2012) observed clear long-term (greater than 10 years) displacement of harbor porpoises from commercial wind farm areas in Denmark. Displacement effects remain a focus of ongoing study (Kraus et al. 2019). Other studies have documented apparent increases in marine mammal density around wind energy facilities. For example, Russel et al. (2014) found clear evidence that seals were attracted to a European wind farm, apparently by the abundant concentrations of prey supported by artificial reef effects. Gray seals are particularly susceptible to entrapment in trawl fisheries (Lyssikatos 2015). If commercial trawling were to occur near wind farms, increased interactions and resulting mortality of gray seals could occur.

Hayes et al. (2021, 2022) note that marine mammals are following shifts in the spatial distribution and abundance of their primary prey resources driven by increased water temperatures and other climate-related impacts. These range shifts are primarily oriented northward and toward deeper waters. The widespread development of offshore renewable energy facilities could facilitate climate change adaptation for certain marine mammal prey and forage species. The artificial reefs created by these structures form biological hotspots that could support species range shifts and expansions and changes in biological community structure (Degraer et al. 2020; Methratta and Dardick 2019; Raoux et al. 2017). In contrast, broadscale hydrodynamic impacts could alter zooplankton distribution and abundance (van Berkel et al. 2020). There is considerable uncertainty as to how these broader ecological changes would affect marine mammals in the future, and how those changes will interact with other human-caused impacts. The effect of these reef effects and hydrodynamic impacts on marine mammals and their habitats under the No Action Alternative could be beneficial or adverse, and their significance could range from **minor** adverse, negligible, or **moderate** beneficial. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including the nature and extent of effects to forage resources and the status of the affected population and sensitivity to effects to individuals.

The presence of structures could also concentrate recreational fishing around foundations, potentially increasing the risk of marine mammal entanglement in both lines and nets and increasing the risk of injury and mortality due to infection, starvation, or drowning (Moore and van der Hoop 2012). 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). These structures could also result in fishing vessel displacement or changes in gear types that lead to changes in marine mammal exposure to fishing effects. For example, a shift from mobile gear to fixed gear could increase in the number and distribution of vertical lines and buoys in the water column, resulting in an increased risk of marine mammal interactions with fishing gear. The likelihood of such shifts and potential resulting effects to marine mammals is uncertain. However, bycatch and harmful interactions are known occur in various gillnet and trawl fisheries throughout New England and the Mid-Atlantic Coast, with hotspots driven by marine mammal density and fishing intensity (Lewison et al. 2014; Morin et al. 2018; NOAA 2021a; 86 *Federal Register* 51970). Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARW and could be a limiting factor in the species' recovery (Knowlton et al. 2012). Johnson et al. (2005) report that 72% of NARWs show evidence of past entanglements. Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pettis et al. 2021). Entanglement could also be responsible for high mortality rates in other large whale species (Read et al. 2006). Abandoned or lost fishing gear could 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 could still pose a hazard to marine mammals. BOEM anticipates that future projects would perform regular inspections to identify and remove derelict fishing gear and other marine debris from offshore structures. These inspections would provide a mechanism for removing harmful marine debris, reducing associated risks to marine mammals.

Although the type and magnitude of effect from displacement and shifts in prey resources due to the presence of structures are largely unknown, the possibility of changes in distribution relative to commercial fishing activity and increased interaction with fishing gear poses the potential for increased risk of entanglement. Should such changes occur, increased risk of entanglement would constitute a **minor** to **moderate** adverse effect on marine mammals, because this stressor is a documented source of injury and mortality. Effects to each marine mammal species would depend on several factors, including the number of individual animals exposed to entanglement effects, the nature of the impact (i.e., injury or mortality), and the status and sensitivity of the affected population to those impacts. In the case of NARW, given that entanglement has been identified as a limiting factor in the species' recovery, the potential for increased exposure to entanglement could pose a significant risk; however, specific EPMs have been developed to minimize risk for NARW (including monitoring, gear identification, and marine debris management; refer to Appendix F for the full list). The risk of entanglement is therefore not considered to result in a greater than **moderate** adverse effect for NARW. It is important to stress that the likelihood of this level of effect is unclear because it is not known if the presence of structures would displace NARW and whether displacement would lead to increased fishing gear exposure. These potential long-term impacts would persist until decommissioning is complete and structures are removed.

Anticipated EPMs would help to offset the potential impact of entanglement within derelict fishing gear or marine debris.

Vessel traffic: BOEM estimates that construction of future offshore wind projects would begin in earnest in 2022 and conclude in 2030. Vessel activity could peak in 2025 with as many as 210 vessels involved in the construction of reasonably foreseeable projects (see Section 3.16.1.1).

Once future projects reach the O&M phase, they would be serviced by crew transport vessels (CTVs) and SOVs making routine trips between the wind farms and port-based O&M facilities. The number and size of CTVs and number of trips per week required for planned maintenance would vary by project based on the number of WTGs. Increased vessel traffic presents a potential increase in collision-related risks to marine mammals. BOEM anticipates that those risks would be minimized by project-specific EPMs and compliance with additional mitigation measures required as a condition of ESA and MMPA compliance. While these measures are likely to be effective in avoiding adverse effects on sensitive species like NARW, they would not eliminate risks to other marine mammal species.

Unplanned maintenance activities would require the periodic use of larger vessels of the same class used for project construction. Unplanned maintenance would occur infrequently dictated by equipment failures, accidents, or other events. Vessel requirements for unplanned maintenance would also likely vary based on overall project size. Unplanned trips would pose similar vessel-related collision risks to marine mammals as for planned trips, but the potential extent and number of animals potentially exposed cannot be determined without project-specific information. Accordingly, adverse effects to marine mammals from increased vessel activity could range from **minor** to **moderate** adverse throughout construction and O&M.

3.15.2.2.3 Conclusions

Impacts of the No Action Alternative. Under the No Action Alternative, BOEM would not approve the RWF COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on marine mammals associated with the Project would not occur. Baseline conditions of the existing environment would remain unchanged. Therefore, not approving the COP would have no additional incremental effect on marine mammals. Similarly, NMFS's No Action Alternative (i.e., not issuing the requested incidental take authorization) would also have no additional incremental impact on marine mammals and their habitat.

Under the No Action Alternative, ongoing stressors and activities contributing to baseline conditions would result in a range of temporary to long-term impacts (disturbance, displacement, injury, mortality, and reduced foraging success) on marine mammals. Climate change would continue to affect marine mammal foraging and reproduction through changes to the distribution and abundance of marine mammal prey. Vessel activity (vessel collisions) and gear utilization associated with ongoing non–offshore wind activities would continue to cause long-term detectable and measurable injury and mortality to individual marine mammals. Impacts to marine mammals from the construction, O&M, and eventual decommissioning of other planned and permitted offshore wind facilities would occur. Underwater noise from pile driving during construction of those projects would result in detectable impacts on marine mammals; however, these impacts would be short term. Accidental releases and discharges, EMF, the presence of structures, cable emplacement and maintenance, port utilization, and lighting would result in long-term negligible or minor impacts on marine mammals. Although impacts on individual marine mammals and their habitat are anticipated from other offshore wind activities, the level of impacts would be minimized due to the EPMs implemented during construction, operation, and maintenance. The No Action Alternative would result in **minor to moderate** impacts on mysticetes (with the exception of NARW), odontocetes, and pinnipeds and could include **minor beneficial** impacts for some species that benefit from increased prey availability.

Because of the low population size for the NARW and continuing stressors, population-level effects on NARWs are occurring. Vessel activity (vessel collisions) and gear utilization associated with ongoing non–offshore wind activities continue to result in long-term population-level impacts. The effects of climate change further exacerbate impacts on NARW. For NARW, the No Action Alternative (in consideration of baseline conditions) would continue to result in **major** long-term impacts. Ongoing offshore wind construction, operation, and maintenance activities would be conducted with applicant-proposed and agency-required mitigation measures developed to avoid and minimize impacts on NARW; therefore, impacts from offshore wind activities are not anticipated to substantially contribute to the major impacts.

<u>Cumulative impacts of the No Action Alternative</u>. Under the No Action Alternative, existing environmental trends and ongoing activities would continue in addition to impacts from planned offshore wind activities. Mysticetes, odontocetes, and pinnipeds would continue to be affected by natural and human-caused IPFs. Planned non–offshore wind activities would also contribute to impacts on marine mammals. Planned non–offshore wind activities include increasing vessel traffic; new submarine cable and pipeline installation and maintenance; marine surveys; commercial and recreational fishing activities; marine minerals extraction; port expansion; channel-deepening activities; military readiness activities; and the installation of new towers, buoys, and piers. BOEM anticipates that planned non–offshore wind activities would result in moderate long-term impacts on marine mammals (with the exception of NARW) primarily driven by ongoing underwater noise impacts, vessel activity (vessel collisions), entanglement, seabed disturbance, and the lack of knowledge regarding any mitigation and monitoring requirements for these planned non–offshore wind activities. BOEM anticipates that the combined ongoing and planned activities would result in moderate impacts on marine mammals (with the exception of NARW, which would remain major). Additionally, the presence of structures could provide **beneficial** impacts on some marine mammal species.

Cumulative impacts to NARW are in many cases more severe than otherwise similar impacts to other marine mammal species. Due to the imperiled status of the population, impacts that lead to loss or reduced fitness of even one individual could compromise the viability of the species, which would constitute a major impact per the definitions provided in Section 3.3. Offshore wind construction, operation, and maintenance activities would be conducted with applicant-proposed and agency-required mitigation measures developed to minimize impacts on NARW; therefore, impacts from offshore wind activities are not anticipated to substantially contribute to the existing major impacts from baseline conditions.

On this basis, BOEM anticipates that the cumulative impacts of the No Action Alternative would result in **minor** to **moderate** impacts on mysticetes, odontocetes, and pinnipeds, with the exception of the NARW, on which impacts would be **major**. Impacts on individual NARWs could have population-level effects, and it is unknown whether the population can sufficiently recover from the loss of an individual to maintain the viability of the species.

The No Action Alternative would forgo any long-term monitoring that Revolution 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.

3.15.2.3 Alternative B: Impacts of the Proposed Action on Marine Mammals

Under the Proposed Action, baseline conditions for marine mammals (see Section 3.15.1) would continue to follow current regional trends within the GAA. Under Alternative B, BOEM would approve the COP for the Proposed Action. The impacts of each IPF from the construction and installation, O&M, and conceptual decommissioning of the Proposed Action would be incremental to and would compound the impacts of baseline conditions on each marine mammal population considered in this EIS (see Table 3.15-2). These effects are described below.

3.15.2.3.1 Construction and Installation

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: Effects on marine mammals from anchoring and cable emplacement activities during Project construction would primarily result from noise and disturbance related to vessel activity and exposure to suspended sediments from seafloor disturbance. Potential effects from exposure to vessel activity and suspended sediments from seafloor disturbance are described below under the vessel traffic and sediment deposition and burial IPFs, respectively. Entanglement risks to marine mammals from vessel anchoring and cable emplacement are not anticipated. Only larger construction and O&M vessels would anchor to the seafloor using large heavy anchor chains. Per the COP, no divers would be used and no lines or rigging are anticipated for cable installation and maintenance. Transmission cables and jet plow umbilicals are large in diameter, relatively inflexible, and under constant tension throughout installation. Therefore, the likelihood of marine mammal entanglement is discountable.

Anchoring and cable emplacement effects could lead to short-term adverse effects on invertebrate and finfish prey species. Effects on marine mammal prey resources are described in detail in Sections 3.6.2.2.1 and 3.13.2.2.1, respectively. While indirect effects to fish and invertebrate prey resources would occur, these impacts are not likely to significantly affect the availability of prey and forage resources for any marine mammal species and would therefore be **negligible** adverse. Therefore, anchoring and cable emplacement during construction would have **negligible** adverse effects on marine mammals.

Noise: Construction of the RWF and RWEC would produce short-term underwater and airborne noise with the potential to affect marine mammals. Construction noise sources include impact and vibratory pile driving, HRG surveys, UXO detonation, construction vessels, and helicopters and fixed-wing aircraft. The COP includes EPMs that the Project has committed to implementing and are described in Appendix F, Table F-1.

Impact pile driving would be used to install up to 100 RWF WTG and two OSS foundations. Vibratory pile driving could be used to construct the temporary cofferdam at the RWEC sea-to-shore transition. Construction vessels would be used throughout RWF and RWEC construction. Impact hammer installation of the RWF WTG and OSS foundations would produce underwater noise impacts with the greatest amount of exposure and highest potential to cause injury-level effects on marine mammals, based on likelihood of occurrence and extent of impacts.

Vibratory pile driving would generate intense non-impulsive noise impacts. Non-impulsive noise is less likely to cause injury to marine mammals, but the loud, continuous sound field generated by these sources can interfere with, or mask, communication and the ability to detect predators and locate prey (Hatch et al. 2012; Putland et al. 2017). When moving, construction vessels and marine mammals are moving in relation to one another. This tends to limit the duration of exposure such that injury-level effects are unlikely, but exposures exceeding behavioral harassment thresholds could still occur. In contrast, vibratory pile driving used to install the temporary cofferdam at the RWEC sea-to-shore transition site would be stationary. Vibratory pile-driving noise can cause auditory masking effects over great distances. Vessel engines also produce non-impulsive low frequency sound. While lower in intensity than vibratory pile driving, vessel engines operate continuously and can substantially alter the ambient noise environment.

UXOs could also be present within the maximum work area, and if these devices cannot be safely relocated or avoided, they may need to be detonated in place before bed-disturbing construction activities begin. Revolution Wind would follow an industry-standard process that minimizes the number of potential detonations (see COP Appendix G [Ordtek 2021]). These measures range from relocating the activity away from UXO, moving the UXO away from the activity, or cutting the UXO open to deactivate fused munitions or low-order detonation. These measures would be considered prior to in-situ UXO disposal. As of February 2023, 16 UXOs have been identified in the RWEC corridor. Revolution Wind has determined that all 16 devices can be safely avoided by shifting the cable route within the approved installation corridor without the need for detonation (Orsted 2023). However, additional devices of unknown size and location could be discovered during preconstruction surveys or construction that cannot be avoided or safely relocated. BOEM has concluded that the need for UXO detonation cannot be entirely ruled out; therefore, the potential effects of this activity on marine mammals are considered herein. The applicant has developed an assessment of potential underwater noise impacts on marine mammals, sea turtles, and finfish from UXO detonation, considering a range of warhead sizes ranging from 5 to 1,000 pounds (2.3 to 454 kg) (Hannay and Zykov 2022). The analysis presented herein considers impacts from detonation of the largest UXOs potentially occurring in the maximum work area. UXO detonation could overlap with other construction noise, but these effects have not been analyzed.

Underwater noise impacts on marine mammals are evaluated using behavioral and injury-level thresholds for different marine mammal species groups developed by NMFS (GARFO 2020; NOAA 2018) and TTS (i.e., temporary hearing impairment) exposure thresholds developed by the U.S. Navy (2017). Specific injury thresholds are defined for different marine mammal species groups based on hearing sensitivity. These thresholds are summarized in Table 3.15-5. As shown, marine mammals are organized into four groups based on hearing sensitivity, specifically the range of sound frequencies they are most sensitive to. NOAA (2018) has defined dual injury criteria for each group that can be used to evaluate the potential for hearing injury from exposure to different types of noise exposure, such as instantaneous exposure to a single pile strike, cumulative exposure to multiple pile strikes, cumulative exposure to UXO detonation, or cumulative exposure to non-impulsive sources like vibratory pile driving or vessel noise (NOAA 2018). NMFS (NOAA 2018) and the U.S. Navy (2017) have also defined threshold criteria for behavioral and TTS effects from impulsive noise sources and for behavioral effects from non-impulsive noise sources (see Table 3.15-5). The TTS thresholds are used to assess temporary hearing impairment impacts from UXO detonation; the behavioral thresholds are used to assess effects of other construction-related noise (e.g., pile driving, vessel noise).

Revolution Wind evaluated the potential for exposure to UXO-detonation-related noise impacts associated with the onset of lung and gastrointestinal (i.e., non-auditory) injuries ranging from minor up to and including potential mortality (Hannay and Zykov 2022; U.S. Navy 2017). Non-hearing-related injury thresholds are determined by equations that consider animal mass and depth at the time of exposure. Tables 3.15-6 and 3.15-7 present the animal mass estimates for different marine mammal groups and the equations used to calculate non-auditory injury thresholds for UXO detonation. The threshold formulas presented in Table 3.15-7 are based on observed onset of injuries to 1% of individuals in U.S. Navy (2017) test studies. BOEM is not presenting threshold distances for non-auditory injury and mortality from UXO detonation in Table 3.15-5, because animal size and water column position at the time of exposure will vary on a case-by-case basis. Hannay and Zykov (2022) considered a range of potential exposure scenarios and found that non-auditory threshold exposure distances for mitigated UXO detonations were less than those for auditory injury and temporary hearing impairment and within the pre-clearance zones for marine mammals proposed by Revolution Wind. Because the threshold distances for potential auditory injury and temporary hearing impairment will always be larger than those for non-auditory injury for a given marine mammal group, BOEM is relying on the latter to determine the potential for adverse noise impacts. BOEM is applying the guidance and thresholds currently accepted by NOAA (2018) to assess underwater noise impacts. BOEM also recognizes that marine mammal hearing is an evolving science, and improved understanding (e.g., Southall et al. 2019) could lead to future refinements.

Table 3.15-5. Underwater Noise Exposure Thresholds for Permanent Hearing Injury and Behavioral Disruption by Marine Mammal Hearing Group

Hearing Group	Type of Effect	Type of Exposure	Value	Units
LFC	Permanent hearing injury	Cumulative SEL (impulsive)*	183	SEL dB re 1 μPa²·s
		Cumulative SEL (non-impulsive)	199	SEL dB re 1 μPa²·s
		Peak injury (impulsive)*	219	dB re 1 μPa
	Behavioral harassment/	Behavioral (intermittent)	160	dB re 1 μPa
	Temporary hearing impairment	TTS (peak)*	213	dB re 1 μPa
		TTS (cumulative SEL)*	168	SEL dB re 1 μPa²·s
		Behavioral (continuous)	120	dB re 1 μPa²·s
MFC	Permanent hearing injury	Cumulative SEL (impulsive)*	185	SEL dB re 1 μPa²·s
		Cumulative SEL (non-impulsive)	198	SEL dB re 1 μPa²·s
		Peak injury (impulsive)*	230	dB re 1 μPa
	Behavioral harassment/	Behavioral (intermittent)	160	dB re 1 μPa
	Temporary hearing impairment	TTS (peak)*	224	dB re: 1 μPa
		TTS (cumulative SEL)*	170	SEL dB re 1 μPa²·s

Hearing Group	Type of Effect	Type of Exposure	Value	Units
		Behavioral (continuous)	120	dB re 1 μPa
HFC	Permanent hearing injury	Cumulative SEL (impulsive)*	155	SEL dB re 1 μPa²·s
		Cumulative SEL (non-impulsive)	173	SEL dB re 1 μPa²·s
		Peak injury (impulsive)*	202	dB re 1 μPa
	Behavioral harassment/ Temporary hearing impairment	Behavioral (intermittent)	160	dB re 1 μPa
		TTS (peak)*	196	dB re 1 μPa
		TTS (cumulative SEL)*	140	SEL dB re 1 μPa²·s
		Behavioral (continuous)	120	dB re 1 μPa
Seals and sea lions (Phocids)	Permanent hearing injury	Cumulative SEL (impulsive)*	185	SEL dB re 1 μPa²·s
		Cumulative SEL (non-impulsive)	198	SEL dB re 1 μPa²·s
		Peak injury (impulsive)*	218	dB re 1 μPa
	Behavioral harassment/ Temporary hearing impairment	Behavioral (intermittent)	160	dB re 1 μPa
		TTS (peak)*	212	dB re 1 μPa
		TTS (cumulative SEL)*	170	SEL dB re 1 μPa²·s
		Behavioral (continuous)	120	dB re 1 μPa

Source: GARFO (2020); NMFS (2018); U.S. Navy (2017).

Note: SEL = sound exposure level.

* The identified values were used in the analysis of UXO detonation effects (Hannay and Zykov 2022; U.S. Navy 2017).

Table 3.15-6. Representative Calf/Pup and Adult Mass Estimates Used for Assessing Impulse-based Onset of Lung Injury and Mortality Threshold Exceedance Distances

Impulse Animal Group	Representative Species*	Calf/Pup Mass (kilograms)	Adult Mass (kilograms)
Baleen whales and sperm whale	Sei whale (*Balaenoptera borealis*) Sperm whale (*Physeter macrocephalus*)	650	16,000
Pilot and minke whales	Minke whale (*Balaenoptera acutorostrata*)	200	4,000
Beaked whales	Gervais' beaked whale (*Mesoplodon europaeus*)	49	366
Dolphins, kogia, pinnipeds, and sea turtles	Harbor seal (*Phoca vitulina*)	8	60
Porpoises	Harbor porpoise (*Phocoena phocoena*)	5	40

*Species presented here are representative for the impulse animal group as presented by U.S. Navy (2017). Some species shown and do not necessarily occur within the RWF or RWEC corridor.

Table 3.15-7. Thresholds for Onset of Non-auditory Injury Based on Observed Effects on 1% of Exposed Animals

Hearing Group	Mortality (severe lung injury)*	Slight Lung Injury*	Gastrointestinal Tract Injury
All marine mammals	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa·s	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa·s	$L_{pk,flat}$: 237 dB

Source: U.S. Navy (2017).

Notes:

M = animal (adult and/or calf/pup) mass (kilograms) (see Table C.9 in U.S. Navy [2017])

D = animal depth (meters).

* Lung injury (severe and slight) thresholds are dependent on animal mass.

Kusel et al. (2023) and Hannay and Zykov (2022) developed sound source level estimates for monopile installation and UXO detonation activities that could occur under the Proposed Action. They then used those source values to estimate the distance required for that noise to attenuate to the marine mammal exposure thresholds. LGL (2022) reported comparable sound source estimates for vibratory pile driving used for sea-to-shore transition construction. Assessment of construction vessel noise is based on the analysis presented in Denes et al. (2021). The resulting values based on summer modeling conditions, presented in Table 3.15-8, represent a radius extending around each noise source where potential injury and behavioral-level effects could occur. The single strike injury distances apply only to impact pile driving and represent how close a marine mammal would have to be to the source to be instantly injured by a single pile strike. The cumulative injury distances are based on exposure ranges that consider total estimated exposure accounting for animal movement. The behavioral and TTS values are instantaneous exposure distances, meaning that any animal within the effect radius is assumed to have experienced a temporary to short-term adverse effect.

Using the information presented in Tables 3.15-6 and 3.15-7, Hannay and Zykov (2022) also assessed the potential for non-auditory injury (i.e., lung and gastrointestinal injury). As noted, the potential for non-auditory injury is dependent on water depth, animal mass, and device size. Across the range of depths, animal mass, and device sizes assessed, the onset of lung injury may occur within 16 to 2,126 feet of a detonation, and mortality may occur within 16 to 1,158 feet of a detonation. Gastrointestinal injury may occur within 69 to 410 feet of a detonation. These distances assume use of an attenuation system achieving 10-dB sound source reduction. As evident in Table 3.15-6, the potential for auditory injury from UXO detonation typically occurs within a much larger radius around the detonation than the potential for non-auditory injury. However, depending on the device size, it is possible that an individual could experience both non-auditory and auditory injury.

Table 3.15-8. Distance Required to Attenuate Underwater Construction Noise below Marine Mammal Injury and Behavioral Effect Thresholds by Activity and Hearing/Species Groups, based on Exposure Range (ER95%) Values

Construction Activity	Number of Sites	Total Days	Species Group	Distance to Peak Injury Threshold (feet)	Distance to Cumulative Injury Threshold (feet)^	Distance to Behavioral or Cumulative TTS Effect Threshold (feet) ^
12-meter WTG monopile foundation installation*	100	33	LFC	< 33	4,954–8,727	11,909–12,336
			MFC	–	0–66	0–12,041
			HFC	525	4,396	11,877
			Phocid pinnipeds (earless/true seals)	–	787–1,444	11,909–12,467
15-meter OSS monopile foundation installation*	2	2	LFC	< 33	3,084–5,873	11,516–11,877
			MFC	–	–	0–11,909
			HFC	361	2,723	11,483
			Phocid pinnipeds (earless/true seals)	–	33–1,214	11,549–12,303
Temporary cofferdam installation and removal†	1	56	LFC	Not applicable (N/A)	4,823	120,374
			MFC	N/A	–	68,537
			HFC	N/A	207	52,598
			Phocid pinnipeds (earless/true seals)	N/A	338	100,784
HRG surveys†,‡	10,775 linear survey miles	248	LFC	N/A	5	463
			MFC	N/A	<3	463
			HFC	N/A	120	463
			Phocid pinnipeds (earless/true seals)	N/A	<3	463

Construction Activity	Number of Sites	Total Days	Species Group	Distance to Peak Injury Threshold (feet)	Distance to Cumulative Injury Threshold (feet)^	Distance to Behavioral or Cumulative TTS Effect Threshold (feet) ^
Construction vessel operation§	N/A	765	LFC	N/A	367	48,077
			MFC	N/A	115	44,236
			HFC	N/A	338	42,362
			Phocid pinnipeds (earless/true seals)	N/A	164	47,001
UXO detonation¶,#	13	13	LFC	466–2,776	883–14,009	8,629–44,291
			MFC	138–846	167–1,755	1,243–9,613
			HFC	3,025–17,615	5,512–22,835	19,783–51,181
			Phocid pinnipeds (earless/true seals)	518–3,091	236–6,004	3,707–25,656

^ Distances to thresholds for peak exposure, behavioral effects exposure, and UXO detonation are exposure ranges, which describe the area within which 95% of exposed animals would experience the effect from instantaneous exposure (R95%). Cumulative injury and TTS (i.e., temporary hearing impairment) threshold distances are exposure ranges (ER95%). Exposure ranges account for animal movement and are used to determine the number of animals likely to be exposed to cumulative exposure effects.

* Data from Kusel et al. (2023). Values shown are the range of effect threshold distances across all modeled species in each hearing group for summer installation of 12-m WTG monopiles and 15-m OSS monopiles. Installation scenario for 12-m monopiles is 10,740 strikes/pile at installation rate of three piles/day. Installation scenario for a 15-m monopile is 11,563 strikes/pile at installation rate of up to two piles/day. All piles installed with a maximum 4,000-kJ hammer with an attenuation system achieving 10-dB sound source reduction.

† Data from LGL (2022) for a sheet pile cofferdam installed using a vibratory hammer. Distance to threshold estimated assuming the use of AZ-type sheet piles, with a maximum of 56 pile-driving days (for installation and removal). Threshold distances shown do not consider geographic confinement by surrounding shorelines of Narragansett Bay.

‡ HRG survey values are maximum threshold distances for each hearing group for the loudest type of equipment likely to be employed, as reported by LGL (2022).

§ Data from Denes et al. (2021). Analysis considered use of dynamic positioning thrusters by construction vessels. This analysis did not consider the timing, frequency, and duration of noise from background vessel traffic in and near the Lease Area. Noise levels produced by construction vessels are expected to be similar to these background sources.

¶ The range of values shown are the minimum and maximum threshold distances for detonation of UXOs ranging in size from 5 to 1,000 pounds at four modeled sites with 10 dB of sound attenuation (Hannay and Zykov 2022). The 1,000-pound UXO is the largest potential explosive device potentially occurring in the maximum work area.

Peak and cumulative PTS threshold distances calculated by Hannay and Zykov (2022) for detonation of 5 to 1,000-pound UXOs with 10 dB of sound attenuation. NOAA uses the larger cumulative threshold distance to assess potential PTS (i.e., hearing injury) and TTS (i.e., temporary hearing impairment) exposure resulting from UXO detonation (Hannay and Zykov 2022). Hearing injury and temporary hearing impairment exposure could occur anywhere within zones of exposure ranging from 46,139 to 567,221 acres within and around the maximum work area for the RWF and RWEC. The size of a potential exposure area will vary within this range by hearing group and the type of exposure (i.e., PTS or TTS). The location of detonation impacts and actual likelihood of exposure would depend on where UXOs are encountered.

The PDE for the Proposed Action includes the installation of up to 100 12-meter and two 15-meter monopile foundations using an impact hammer. The installation scenario considered in the acoustic analysis assumes each WTG monopile installation would require up to 10,740 strikes from an impact hammer ranging in energy from 1,000 kJ to 4,000 kJ over 4 hours to achieve desired depth. Up to three WTG monopiles could be installed in 1 day. The 15-meter OSS monopiles would require up to 11,563 strikes from an impact hammer ranging in energy from 1,000 kJ to 4,000 kJ and up to two piles would be installed per day. After each pile is driven to depth, the construction vessel would attach appurtenant platforms and equipment and then reposition to the next foundation site. Additionally, detonation of UXOs within the work area may be required. The UXO exposure distance estimates (presented in Table 3.15-8) reflect the planned use of a noise attenuation system that would reduce the source noise level by an average of 10 dB per hammer strike, which has been demonstrated with currently available technologies under other circumstances (Bellman et al. 2020).

Monopile installation and UXO detonation are the most likely sources of permanent hearing injury and other temporary to short-term effects to marine mammals from Project-related underwater noise. UXO detonation may also result in non-auditory injury (i.e., lung and gastrointestinal tract compression injuries); these effects are dependent on water depth and animal mass (Hannay and Zykov 2022). The likelihood of injury from underwater noise also depends on proximity to the noise source, the intensity of the source, sensitivity to the sound source, and the duration of noise exposure. A summary of the distances required to attenuate impact pile-driving noise for WTG and OSS foundation installation and UXO detonation below exposure thresholds is provided in Table 3.15-8. As shown, the threshold distances for different types of effects varies between marine mammal species depending on hearing sensitivity. For example, a low-frequency cetacean would have to remain within 8,727 feet of a 12-meter monopile installation for 24 hours to experience permanent cumulative hearing injury, referred to as PTS. In contrast, the same animal could immediately experience PTS if it were within 14,009 feet from detonation of a 1,000-pound UXO. Mid-frequency cetaceans and phocid pinnipeds are less sensitive to the intense, low-frequency sounds produced by impact pile driving and would have to be much closer to the source to be injured. For example, phocid pinnipeds would need to remain within less than 1,444 feet of a 12-meter monopile installation for 24 hours to experience cumulative injury. Aversion responses (avoidance of sound levels or acoustic sources that are disturbing or injurious) by marine mammals have been documented, and available information suggests that mobile marine mammals are likely to leave areas where potentially harmful noise effects are occurring (Dunlop et al. 2017; Ellison et al. 2012; Southall et al. 2007). A detailed discussion of noise impacts on marine mammals is provided in Vineyard Wind final EIS Section 3.4.1.1.1 (BOEM 2021b).

Vibratory pile driving used during construction of the RWEC sea-to-shore transition would create an exposure area for underwater sound pressure levels in excess of the 120 dB re 1 μPa threshold (NMFS 2019) for behavioral harassment from continuous noise sources. Based on sound source modeling conducted to support the Revolution Wind incidental take petition (LGL 2022), vibratory pile-driving noise could theoretically extend outward from the cofferdam site up to 31,955 feet (6.05 miles). The surrounding shorelines of Narragansett Bay would restrict the maximum distance vibratory pile-driving noise could travel, limiting potential exposure to those marine mammal species that are likely to occur within this enclosed embayment. Vibratory pile-driving noise could occur for up to 8 hours per day over a maximum of 56 days: 28 days for installation and 28 days for removal.

HRG surveys would also generate impulsive noise but at a lower intensity than impact pile driving, limiting the duration of exposure. Additionally, as the equipment is mobile, the sound source and marine mammal receptors would be moving in relation to one another, further limiting the duration of exposure. Injury-level effects are therefore unlikely, but exposures exceeding behavioral thresholds could still occur. Revolution Wind estimates that up to 10,779 linear miles of preconstruction HRG surveys would occur over 248 days, averaging approximately 43.5 linear miles of exposure each day at a typical vessel speed of 4 knots (LGL 2022). As discussed under the No Action Alternative, BOEM (2021a) reviewed underwater noise levels produced by the available types of HRG survey equipment and NMFS (2021) concurred with BOEM's determination that the loudest available equipment types would be unlikely to injure or measurably affect the behavior of ESA-listed marine mammals. While individual marine mammals may be exposed to HRG survey noise sufficient to cause behavioral effects, those effects would be temporary in nature and unlikely to cause any perceptible longer-term consequences to individuals or populations.

As discussed above, the Revolution Wind–committed EPMs would effectively minimize injury risks to most marine mammals from instantaneous and cumulative noise exposure. Nighttime pile driving is proposed, but NMFS's ITA would require sufficient demonstration of the effectiveness of proposed monitoring and mitigation protocols in the form of a nighttime pile-driving plan prior to initiating any nighttime pile driving. Initial evaluation of monitoring equipment suggests that combined acoustic and visual monitoring methods can be effective for monitoring in the dark (ThayerMahan 2023). Proposed measures emphasize protection of the critically endangered NARW and concentrate construction within a timing window when this species is least likely to be present. This timing window is not protective for all species, and some impact areas for PTS, as well as behavioral effects, are large enough that the potential for individual exposure cannot be ruled out.

Kusel et al. (2023) modeled sound attenuation distance to hearing injury thresholds for construction-related impact pile driving and developed estimates of the number of marine mammals that could be exposed to potential adverse noise-related effects from the Proposed Action to support MMPA compliance. Hannay and Zykov (2022) similarly modeled the attenuation distance to marine mammal hearing and bodily injury thresholds for UXO detonation. Using habitat-based density modeling results reported by Roberts et al. (2016, 2017, 2018, 2021), LGL (2022) then calculated the take associated with these modeled exposure estimates incorporating other factors, such as proposed mitigation measures and marine mammal group sizes. The take results are summarized in Tables 3.15-9 and 3.15-10. LGL (2022) used a sophisticated exposure model to estimate the number of individuals by species that could be exposed to PTS (i.e., permanent hearing injury), TTS (i.e., a temporary and recoverable loss of hearing sensitivity), and other short-term physiological and behavioral effects from exposure to each source of construction noise (e.g., impact pile driving, vibratory pile driving, UXO detonation). The modeled exposure scenario for each species assumed an aggressive construction schedule of up to three WTG monopiles installed per day for 30 days (90 total) during the highest density month of species occurrence in the area and the remaining 10 WTG monopiles and two OSS monopiles installed during the month with the second-highest density. The exposure scenario for UXOs assumes that thirteen 1,000-pound devices would require detonation within the RWF and RWEC work areas and that the devices are distributed spatially such that the exposure areas would not overlap. Additionally, detonations would be limited to one per day, and the noise would be instantaneous, so there would be no temporal overlap in exposure. As stated, Revolution Wind has determined that all 16 UXOs identified within the RWEC corridor can be avoided; therefore, the values presented in Tables 3.15-9 and 3.15-10 are a useful upper bound for estimating the number of animals potentially exposed if additional devices are discovered. Modeling scenarios assume timing restrictions and the use of a noise attenuation system capable of achieving at least a 10-dB reduction in sound source level. Exposure may be further minimized by other established measures (e.g., pre-start clearance zone monitoring using protected species observers (PSOs) and passive acoustic monitoring (PAM), use of night vision equipment and infrared/thermal imaging technology at night, soft starts, and shutdown procedures). Recent work suggests that the use of infrared technology at night is as effective for detecting marine mammals as daylight visual monitoring (Guazzo et al. 2019; Verfuss et al. 2018). See Appendix F, Table F-1 for a complete list of EPMs.

Table 3.15-9. Estimated Number of Marine Mammals Experiencing a Permanent Threshold Shift from Worst-Case Scenarios for Construction-Related Impact Pile Driving and Unexploded Ordinance Detonation Exposure

Functional Hearing Group	Species	Source: Impact Pile Driving Exposure†	Source: UXO Detonation Exposure‡
LFC	Blue whale§	–	–
	Fin whale§	–	–
	Minke whale	–	–
	Sei whale§	–	–
	Humpback whale	8	–
	NARW§	–	–
MFC	Sperm whale§	–	–
	Atlantic spotted dolphin	–	–
	Atlantic white sided dolphin	–	–
	Common bottlenose dolphin	–	–
	Common dolphin	–	–
	Risso’s dolphin	–	–
	Pilot whale*	–	–
HFC	Harbor porpoise	–	49
Phocid pinnipeds	Gray seal	–	3
	Harbor seal	–	5

Source: LGL (2022).

Note: Estimated number of individuals is based on established injury thresholds. Cumulative exposure estimates for impact pile driving are based on exposure ranges that consider animal movement modeling for each species. UXO exposure estimates are based on acoustic ranges.

† Modeled exposure estimates based on a worst-case scenario impact hammer installation schedule of 100 12-meter WTGs and two 15-meter OSS monopiles, with up to three WTGs per day and up to two OSSs per day. Installation scenario assumes use of a noise attenuation system achieving 10-dB effectiveness and seasonal restrictions but does not consider other EPMs or mitigation measures.

‡ Model exposure estimates based on worst-case UXO scenario considering detonation of thirteen 1,000-pound (454-kg) explosives with 10 dB of noise attenuation at locations with non-overlapping spatial or temporal impacts. As described in the

text and based on information available as of February 2023 (Orsted 2023), this is likely an overestimate of impacts from UXO detonation.

[§] Listed under the ESA.

* Group includes both long-finned and short-finned pilot whales. Short-finned pilot whales are considered to be rare within the Lease Area because preferred habitat is not present.

Table 3.15-10. Estimated Number of Marine Mammals Experiencing Behavioral Effects from Construction-Related Activities

Functional Hearing Group	Species	Year 1 (construction)	Year 2 (construction)	Year 3 (O&M)	Year 4 (O&M)	Year 5 (O&M)	Current Stock Abundance	Number of Individuals Exposed as Percent of Stock Abundance
LFC	Blue whale[§]	3	1	1	1	1	402	1.7%
	Fin whale[§]	44	2	2	2	2	6,802	0.8%
	Humpback whale	85	5	5	5	5	1,396	7.5%
	Minke whale	344	5	5	5	5	21,968	1.7%
	North Atlantic right whale[§]	50	2	2	2	2	338	16.8%
	Sei whale[*]	20	2	2	2	2	6,292	0.4%
MFC	Atlantic spotted dolphin	87	29	29	29	29	39,921	0.5%
	Atlantic white-sided dolphin	312	28	28	28	28	93,233	0.5%
	Bottlenose dolphin	211	29	29	29	29	62,851	0.5%
	Common dolphin	4,532	659	659	659	659	172,974	4.1%
	Pilot whales*	27	9	9	9	9	68,139	0.1%
	Risso's dolphin	30	6	6	6	6	35,215	0.2%
	Sperm whale[§]	8	2	2	2	2	4,349	0.4%
HFC	Harbor porpoise	1,283	33	33	33	33	95,543	1.5%
Phocid pinnipeds	Gray seal	1,073	49	49	49	49	27,300	4.6%
	Harbor seal	2,669	109	109	109	109	61,336	5.1%

Source: Hayes et al. (2021, 2022); LGL (2022).

Note: Estimated number of individuals is based on established TTS and behavioral thresholds. TTS thresholds were used to determine exposure estimates to temporary hearing impairment from UXO detonation, while all other exposure estimates are based on the established behavioral thresholds for intermittent and continuous noise (refer to Table

3.15-5). Based on information available as of February 2023 (Orsted 2023), the effects associated with UXO detonation are likely overestimated here because the analysis assumes detonation of thirteen 1,000-pound (454-kg) explosives with 10 dB of noise attenuation at locations with non-overlapping impacts.

§ Listed under the ESA.

* Group includes both long-finned and short-finned pilot whales. Short-finned pilot whales are considered to be rare within the Lease Area because s preferred habitat is not present.

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As shown in the above tables, LGL (2022) estimates that four species of marine mammals could experience PTS injury from exposure to underwater noise from impact pile-driving or UXO detonation noise under the Proposed Action. Specifically, up to eight humpback whales, 49 harbor porpoises, three gray seals, and five harbor seals could be exposed to PTS impacts from these activities. Multiple individuals from several species are likely to experience short-term TTS or behavioral effects from exposure to several different sources of Project-related noise, including HRG surveys and sea-to-shore transition construction, in addition to UXO detonation and impact pile driving. TTS and behavioral exposures can have an array of adverse effects on marine mammals, even in the absence of overt behavioral responses. For example, a reduction in effective “communication space” caused by auditory masking can make it more difficult to locate companions and maintain social organization (Cholewiak et al. 2018). This can increase physiological stress, leading to impaired immune function and other chronic health problems (Brakes and Dall 2016; Davis et al. 2017; Hatch et al. 2012). These kinds of effects are most associated with long-term changes in the ambient noise environment, specifically from chronic exposure to noise from increasing levels of marine vessel traffic. All construction-related noise sources would cease once construction is completed, and most animals suffering from TTS or stress from auditory masking and behavioral exposure would be expected to recover fully within hours to days. Therefore, for most marine mammal species, exposure to behavioral-level noise effects would constitute a **minor** impact. Certain species, notably NARW, may be more sensitive to behavioral exposure. NARWs employ a specialized feeding strategy that could be sensitive to behavioral disturbance (van der Hoop et al. 2019), and disturbance that results in missed feeding opportunities could have significant effects on fitness (Fortune et al. 2013). Short-term behavioral disturbance could therefore lead to greater than minor impacts on this species. However, the likelihood of this level of effect resulting from Project-related noise exposure and its significance at the individual or population level is currently unknown.

The exposure estimates reported in Tables 3.15-9 and 3.15-10 consider the application of seasonal restrictions and noise attenuation systems (also termed noise abatement systems) with 10-dB attenuation efficacy. Bellmann et al. (2020) found three noise abatement systems to have proven effectiveness and to be offshore suitable: 1) the near-to-pile noise abatement systems – noise mitigation screen; 2) the near-to-pile hydro sound damper; and 3) for a far-from-pile noise abatement system, the single and double big bubble curtain. With the near-to-pile noise abatement systems – noise mitigation screen or the single big bubble curtain, noise reductions of approximately 15 to 17 dB in depths of 82 to 131 feet (25 to 40 meters) could be achieved. The near-to-pile hydro sound damper system, independent of the water depth, demonstrated noise reductions of 10 dB with an optimum system design. The achieved broadband noise reduction with a single or double big bubble curtain was dependent on the technical-constructive system configuration. Based on Bellmann et al. (2020), the noise mitigation system performance of a 10-dB broadband attenuation assumed for the Project is considered achievable with currently available technologies for pile-driving activities. Additional EPMs and other minimization measures that may further limit exposure include establishment and monitoring of pre-start clearance zones using PSOs and PAM use of night vision equipment and infrared/thermal technology during nighttime pile driving, and soft-start and shutdown procedures. These measures would significantly reduce, but not completely avoid, marine mammal exposure to PTS and TTS or behavioral effects. Overall, underwater noise during construction activities would have a **minor** to **moderate** adverse effect on marine mammals, depending on the species.

LGL (2022) did not explicitly consider construction vessel noise in their exposure assessment. In general, vessel noise is unlikely to cause hearing injury in marine mammals because this would require prolonged exposure close to the source (i.e., remaining within 400 feet of a large vessel for 24 hours, per NOAA [2018]). This is an unlikely scenario. For example, an animal swimming at 2.5 miles per hour, the lower end of average swim speeds for the NARW (Baumgartner and Mate 2005), would travel 400 feet in less than 2 minutes. This animal would clear the zone of noise exposure (i.e., the area in which underwater noise may exceed the baseline) around a stationary construction vessel within approximately 4 hours. The potential for PTS is highly unlikely because it would require an animal remaining within 400 feet of a vessel for 24 hours; behavioral effects may occur but would be spatially and temporally limited. The likelihood and duration of exposure would be further reduced when construction vessels are moving. Animals and vessels moving in relation to each other are likely to reduce the duration of exposure to potential behavioral and auditory masking effects. However, certain marine mammals, notably dolphins, exhibit “bow-riding” behavior. Bow or wake riding provides an energetic advantage, allowing dolphins to travel at high speeds while using less energy (Würsig 2009) and becoming more energy efficient at speeds above 7 knots as compared to normal swimming at speeds below 4 knots (Williams et al. 1992). Individuals attracted to moving vessels would experience prolonged noise exposure, presumably above the behavioral effects threshold. However, a significant portion of construction vessel activity would occur at speeds at or below 4 knots (e.g., cable installation, HRG surveys, installation vessel travel between foundation sites).

As stated above, though it has not been definitively proven, logic and available data (e.g., Dunlop et al. 2017; Ellison et al. 2012; Southall et al. 2007) suggest that mobile marine mammals would avoid behavioral disturbances like those resulting from vessel noise, meaning that the duration of exposure to noise from slow-moving or closely clustered and stationary construction vessels would be limited. It is also important to recognize that a substantial portion of construction vessel activity would occur in areas with high existing levels of vessel traffic. As such, construction vessels would contribute to, but may not substantially alter, ambient noise conditions generated by existing large vessel traffic. While some individual marine mammals could experience short-term behavioral and auditory effects from vessel noise exposure, these effects would be short term in duration and unlikely to cause measurable effects at the broader stock or population-level. Therefore, construction vessel noise impacts on marine mammals would likely be **minor** adverse because of the intermittent nature of the impact and potential for avoidance behavior.

Impact pile-driving noise could indirectly affect marine mammals by killing, injuring or temporarily altering the distribution of fish and invertebrate prey (see Sections 3.6 and 3.13). These effects would be limited in extent, short term, and unlikely to measurably affect the amount of prey available to marine mammals across the OCS because 1) the area of effect is small relative to the available habitat; 2) the loss of individuals would likely be insignificant relative to natural mortality rates for planktonic eggs and larvae across the GAA, which can range from 1% to 10% per day or higher (White et al. 2014); and 3) construction timing along with EPMs intended to avoid noise impacts in areas with sensitive species. Therefore, the indirect effects of underwater noise on marine mammals through impacts to prey species would be short term and **negligible** adverse.

Pile driving also produces airborne noise. NMFS has established a behavioral sound pressure level threshold of 90 dB re 1 μPa for harbor seals and 100 dB re 1 μPa for other otariid and phocid pinniped exposure to airborne noise sources like pile driving (NOAA 2018). No equivalent airborne noise behavioral thresholds have been established for other marine mammal species. Harbor and gray seals are the only pinniped species group expected to occur in the RWF and RWEC vicinity. Based on the cylindrical spreading model described on the website Discovery of Sound in the Sea (University of Rhode Island 2021), behavioral effects could be experienced within approximately 500 and 10 feet from impact and vibratory pile-driving locations, respectively. However, because seals would experience behavioral harassment and injury-level exposures to underwater noise at greater distance, behavioral exposure to airborne noise is unlikely to occur as an independent effect. Moreover, marine mammal observers would monitor the affected area for seals and would halt construction if individuals are observed within these limits (refer to Appendix F, Table F-1), further minimizing the risk of seal exposure to airborne noise impacts (Baker et al. 2013; VHB 2023). On this basis, airborne noise effects on seals would be **negligible** adverse because of the established EPMs and likely avoidance response.

Helicopters and fixed-wing aircraft could also be used during Project construction. Aircraft operations could result in temporary behavioral responses, including short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002), but BOEM does not expect that these exposures would result in biologically significant effects on marine mammals. On this basis, noise and disturbance effects on marine mammals from aircraft operations under the Proposed Action are expected to be **minor** adverse because of protective regulations and the temporary nature of the impact.

Overall, noise effects on marine mammals from proposed construction and installation activities are expected to range from **negligible** to **moderate** adverse, depending on the activity. Based on the likelihood of occurrence and extent of impacts, impact pile driving would produce underwater noise impacts with the greatest amount of exposure and the highest potential to cause injury-level effects on marine mammals.

<u>Presence of structures:</u> Effects on marine mammals from installation of WTG and OSS foundations would result from underwater noise impacts related to impact pile driving and noise disturbance from associated vessel activity. These impacts are described in the Noise IPF section. Indirect effects on marine mammals such as reduced availability of forage or prey could also result from impacts on invertebrate and finfish prey species (see Sections 3.6.2.2.1 and 3.13.2.2.1, respectively). While indirect effects to fish and invertebrate prey resources would occur, these impacts are not likely to significantly affect the availability of prey and forage resources for marine mammals because of their broad resource base and the minimal anticipated adverse effect to fish and invertebrates during the construction phase. Therefore, construction and installation of offshore structures would have temporary, **negligible** to **minor** adverse effects on marine mammals. Effects to each marine mammal species would depend on the magnitude and extent of effects on forage and prey availability, the significance of those effects on individual survival and reproductive fitness, and the status and sensitivity of the affected population to those impacts.

<u>Vessel traffic:</u> Construction and monitoring vessels pose a potential collision risk to marine mammals, and the noise and disturbance generated by vessel presence could temporarily displace individual marine mammals from preferred habitats. Based on information provided by Revolution Wind (Tech Environmental 2023), BOEM estimates that Project construction would require up to 1,407 one-way trips by various classes of vessels between the RWF and regional ports in Rhode Island, Massachusetts, Connecticut, New Jersey, Virginia, and Maryland, as well as ports in Europe over the 2-year construction period. This equates to approximately 59 trips per month or 704 trips per year. In addition, approximately

10,755 linear miles of preconstruction HRG surveys are anticipated to support micrositing of the WTG foundations and cable routes. HRG surveys could occur during any month of the year and would require a maximum of 248 total vessel days. The construction vessels used for Project construction are described in Table 3.3.10-3 in the COP and in Section 3.16. Typical large construction vessels used in this type of project range from 325 to 350 feet in length, from 60 to 100 feet in beam, and draft from 16 to 20 feet (Denes et al. 2021).

Large construction vessels and barges would account for an estimated 23% of these one-way trips, with the remainder comprising CTVs and other small support vessels. BOEM developed a representative analysis of construction vessel effects on regional traffic volume by evaluating the potential increase in transits across a set of analysis cross sections relative to baseline levels of vessel traffic. These cross sections were developed by DNV GL Energy USA, Inc. (2020) to support the COP and are shown in Figures 3.15-2 and 3.15-3.

Using the port of origin information provided by Revolution Wind (Tech Environmental 2023), the estimated 704 construction vessel trips per year would cross transects 13-17 when leaving the RWF and could cross several different transects depending on the destination port. This would equate to a 30% increase in vessel transits across these transects. However, the Automatic Identification System (AIS) data used in transect analysis do not include many recreational vessels that lack AIS transponders and commercial fishing vessels that deactivate their transponders when actively fishing. These two vessel classes account for the vast majority of vessel activity. For example, DNV GL Energy USA, Inc. (2020) estimated over 19,000 one-way trips per year by commercial fishing vessels between the RWF and area ports. When these vessel trips are included, Project construction would result in a 3.1% increase in vessel transits per year across transects 13–17. In summary, this assessment indicates that construction vessels would likely increase vessel traffic to some degree, and large vessel traffic would measurably increase during the 2-year construction period. This indicates the potential for increased risk of marine mammal collisions.

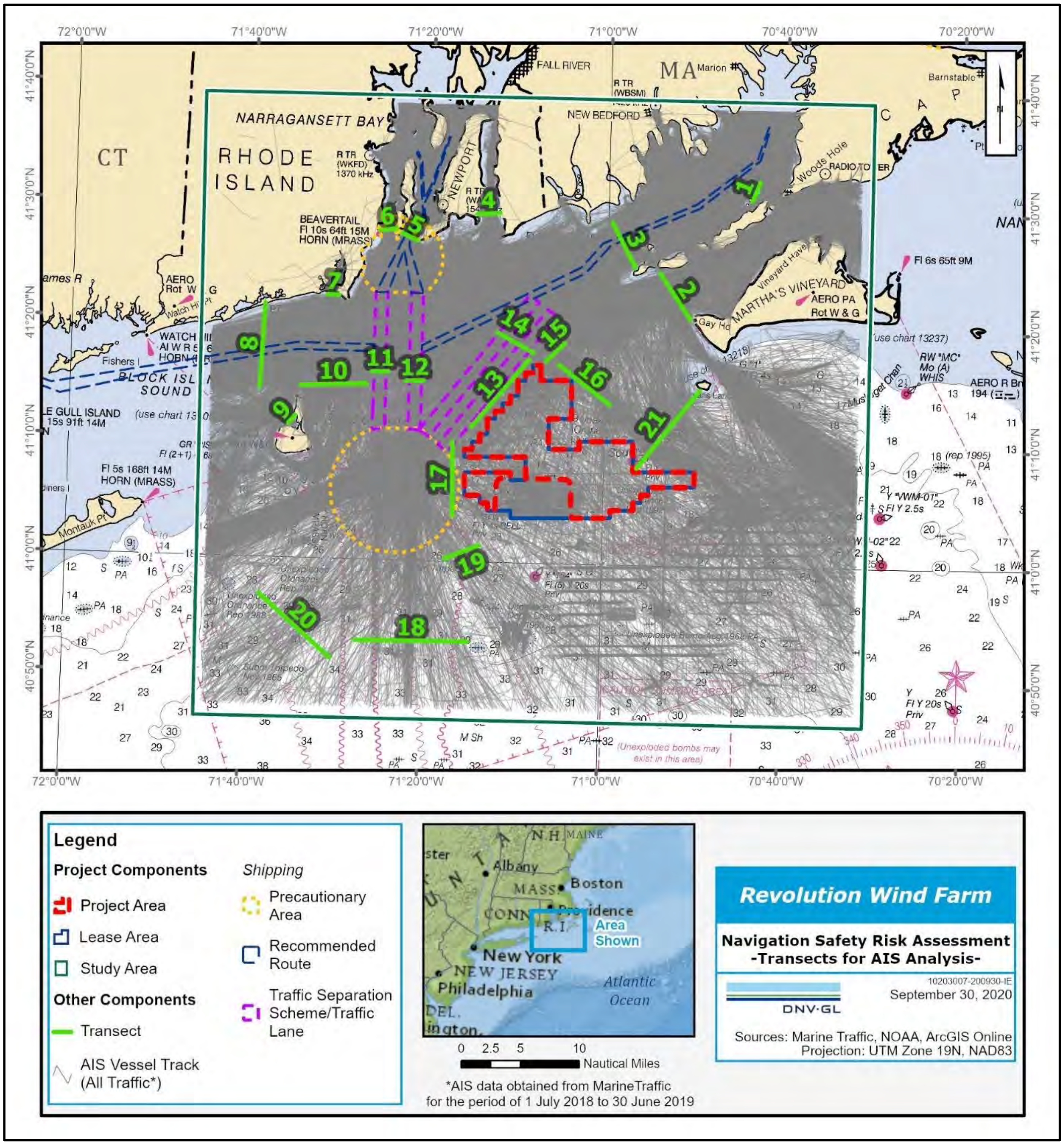

Figure 3.15-2. Automatic Identification System Vessel Traffic Tracks for July 2018 to June 2019 and Analysis Transects Used for Traffic Pattern Analysis (DNV GL Energy USA, Inc. 2020).

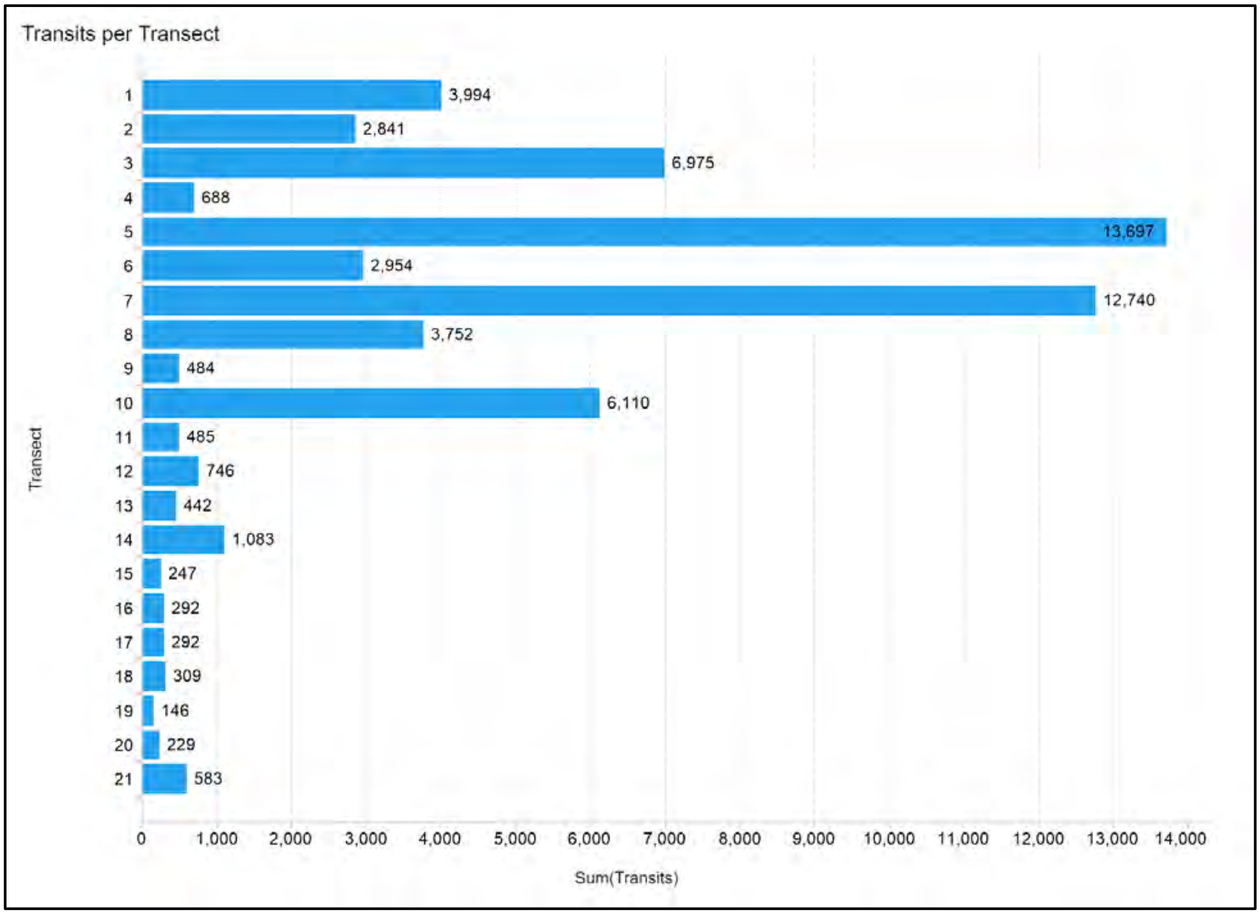

Figure 3.15-3. Vessel Transits of DNV GL Energy USA, Inc. (2020) Analysis Transects Used for Traffic Pattern Analysis from 2018 to June 2019.

Vessel collisions are a key source of mortality and serious injury for many marine mammal species (Hayes et al. 2021, 2022; Laist et al. 2001; Rockwood et al. 2017; Schoeman et al. 2020), indicating the importance of protective measures to minimize risks to vulnerable species. If a vessel strike does occur, the impact on marine mammals would range from **minor** to **moderate** adverse for cetaceans and marine mammals other than NARW, with the impact dependent on the number of individuals exposed and population status. Given the imperiled status of NARW, a vessel collision that results in injury or mortality of even a single individual could constitute a **major** impact. However, the applicant has committed to a range of EPMs to avoid vessel collisions with marine mammals (see Appendix F, Table F-1), and these EPMs, plus additional mitigation measures, are expected to result in a discountable risk of vessel strike. These measures include adherence to NOAA guidance for collision avoidance and a combination of others, including approved speed restrictions for all vessels within marine mammal seasonal management areas (SMAs) and dynamic management areas (DMAs). The proposed EPMs have proven effective at avoiding and minimizing collision risk.

BOEM would ensure that all collision avoidance EPMs will be fully implemented. On this basis, BOEM concludes that vessel strikes are unlikely to occur and therefore there is no anticipated effect on marine mammals. In the event of an unanticipated vessel strike of a marine mammal, Project vessels must immediately cease activities until BOEM is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with all applicable laws (e.g., ESA, MMPA) and COP approval conditions.

All vessel crews would receive training to ensure that these EPMs are fully implemented for vessels in transit. Once on station, the construction vessels either remain stationary when installing the monopiles and WTG/OSS equipment or move slowly when traveling between foundation locations. Cable laying and HRG survey vessels also move slowly, with typical operational speeds of less than 3 knots and approximately 4 knots, respectively, and present minimal risk of collision-related injury.

The densities of most common species of marine mammals likely to occur in the RWF Lease Area and RWEC route are low based on monthly mean density estimates developed by Roberts et al. (2016, 2017, 2018, 2020, 2021, 2022). Project construction of the maximum-case scenario under the Proposed Action would require an estimated maximum of 1,335 one-way trips for all vessel classes combined over the 2-year construction and installation period. Although this would likely be an increase in vessel traffic in and around the maximum work area of approximately 2% a year, the operational conditions combined with planned EPMs would minimize collision risk during construction and installation. Additional mitigation measures agreed upon through agency consultation would further reduce this risk (see Appendix F for all vessel strike avoidance measures). During periods of low visibility, trained crew would use increased vigilance to avoid marine mammals.

Because vessel strikes are not an anticipated outcome given the relatively low number of vessel trips and EPMs to avoid encountering marine mammals, BOEM concludes vessel strikes are unlikely to occur. Therefore, there is no anticipated effect on marine mammals and collision effects would be **negligible** adverse during Project construction.

The presence of construction vessels and associated noise and disturbance could cause short-term displacement of marine mammals from preferred habitats. Temporary marine mammal displacement from offshore wind energy construction sites have been observed, apparently due to vessel-related disturbance, Long (2017). Habitat use within the affected areas returned to normal after construction was completed, indicating that construction-related displacement effects would be short term in duration. On this basis, vessel displacement effects on marine mammals could range in significance from **minor** to **moderate** adverse depending on the species affected and the biological significance of displacement, recognizing that some portion of these effects is also likely the result of construction noise, as described above.

3.15.2.3.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

<u>Anchoring and new cable emplacement/maintenance:</u> Potential anchoring impacts would be similar to the construction phase, but considerably reduced due to fewer anchored vessels. As stated in Section 3.5.2 of the COP, the Project does not anticipate that the IACs, OSS-link cable, and RWEC would require significant maintenance. The cables themselves are unlikely to require repair, but up to 10% of cable protection may need to be replaced over the life of the Project. The IACs, OSS-link cable, and RWEC would be removed from the seafloor during Project decommissioning. Removal of cable protection and extraction of the cable would disturb the seafloor. Vessel anchoring could also be required for specific O&M activities and during Project decommissioning. Effects to marine mammals from cable protection maintenance and vessel anchoring would result primarily from seafloor disturbance, with additional

potential effects from underwater noise exposure and collision risk associated with O&M vessel activity. The latter are addressed under their respective IPFs in the following sections. Entanglement risks to marine mammals from vessel anchoring and cable maintenance and decommissioning are not anticipated. Only larger construction and O&M vessels would anchor to the seafloor, no divers would be used, and no lines or rigging are anticipated for cable maintenance. The methods used to remove transmission cables at the end of project life would be specified in the decommissioning plan. Therefore, the likelihood of marine mammal entanglement from this IPF is discountable.

The resulting effects to marine mammals from cable O&M and decommissioning and O&M vessel anchoring would be similar in nature but lesser in scale and magnitude than those resulting from Project construction. As discussed in Section 3.15.2.1, seafloor disturbance effects on marine mammals during Project construction are anticipated to be **negligible** adverse. As such, seafloor disturbance impacts of similar nature but reduced in scale and magnitude from Project O&M and decommissioning would have **negligible** adverse effects on marine mammals.

Noise: Offshore WTGs produce continuous non-impulsive underwater noise during operations, mostly in lower frequency bands below 8 kHz. The low-frequency sounds produced by WTGs are within the range of hearing sensitivity and audible communication frequencies used by many species of marine mammals (NOAA 2018), indicating that this impact mechanism could be a potential source of behavioral and auditory masking effects on marine mammal species.

As discussed under the No Action Alternative, Tougaard et al. (2020) summarized available monitoring data on wind farm operational noise and determined that operating turbines produce underwater sound pressure levels of approximately 110 to 118 dB re 1 μPa at a reference distance of 50 meters, in the 10-Hz to 8-kHz range. More recently, Stober and Thomsen (2021) used monitoring data and modeling to estimate operational noise from 10-MW current generation direct-drive WTGs (i.e., turbines larger than most previously monitored) and concluded that these designs could generate higher operational noise levels than those reported in earlier research.

The potential for behavioral effects on marine mammals can be evaluated by estimating the area exposed to WTG L_{rms} operational noise above the 120 dB re 1 μPa behavioral harassment threshold for continuous noise sources (NMFS 2019). Applying the practical spreading loss model (spreading coefficient of 15 dB/decade of range) and the general rule of thumb for estimating L_{rms} from zero-to-peak sound pressure level (L_{pk}) (University of Rhode Island 2021),[43] operational ranges of 110 to 118 dB re 1μPa at a reference distance of 164 feet would attenuate below 120 dB re 1 μPa within approximately 35 to 165 feet of each turbine foundation. However, as stated, larger turbines could produce higher operational noise levels that could exceed this threshold at a greater distance.

In addition, it is probable that operational noise would change the ambient sound environment within the Lease Area in ways that could affect habitat suitability. This impact can be evaluated by estimating the area exposed to operational noise above the existing environmental baseline. As discussed under the No Action Alternative, Kraus et al. (2016) measured ambient noise conditions at three locations within and adjacent to the proposed RWF over a 3-year period and identified baseline levels of 102 to 110 dB re 1

[43] An estimate was calculated using the cylindrical spreading loss model (University of Rhode Island 2021).

μPa.[44] Maximum operational noise levels typically occur at higher wind speeds when baseline noise levels are higher due to wave action. Applying the same approach described above, the operational range L_{rms} of 110 and 118 dB re 1 μPa at a reference distance of 50 m would attenuate to the 102 to 110 re 1 μPa baseline within approximately 1,200 feet of each turbine.

Operational noise could interfere with communication and echolocation, reducing feeding efficiency in the areas within a few hundred feet of the monopiles under some conditions. Any such effects would likely be dependent on hearing sensitivity and the ability to adapt to low-intensity changes in the noise environment. Low-frequency cetaceans are more likely to be affected by operational noise as the frequencies generated largely fall within the range of peak hearing sensitivity for these species. These negative impacts could include a variety of long-term physiological and behavioral effects. For example, a reduction in effective "communication space" caused by auditory masking can make it more difficult to find food, locate companions, and maintain social organization (Cholewiak et al. 2018). This can increase physiological stress, leading to impaired immune function and other chronic health problems (Brakes and Dall 2016; Davis et al. 2017; Fortune et al. 2013; Hatch et al. 2012). These kinds of effects are most associated with long-term changes in the ambient noise environment, specifically from chronic exposure to noise from increasing levels of marine vessel traffic. In contrast, mid-frequency cetaceans such as dolphins and sperm whale and high-frequency cetaceans such as harbor porpoise are likely to be less sensitive to the low-frequency sounds generated by operational WTGs because these species are most sensitive to sound at higher frequencies (Johnson 1967; NOAA 2018). Although there can be associated physiological strains, certain species may also be able to acclimatize and adapt to operational noise. For example, while dolphins vocalize in low to middle frequencies, certain species are known to shift vocalization into higher frequency ranges to communicate more effectively in shallow water and adapt to the presence of anthropogenic noise sources (David 2006; Quintana-Rizzo et al. 2006). Therefore, mid-frequency cetaceans are more likely than low-frequency cetaceans to be able to adapt to operational noise effects through responses like shifting their communication frequency range, whereas low-frequency cetaceans may experience interference with communication and echolocation.

On balance, operational noise effects from the RWF are likely to be of low intensity and localized to around each foundation. Jansen and de Jong (2016) and Tougaard et al. (2009) concluded that marine mammals would be able to detect operational noise within a few thousand feet of WTGs, but the effects would have no significant impacts on individual survival, population viability, distribution, or behavior. The findings provided above indicate that operational noise effects would attenuate to ambient levels within a few hundred to a few thousand feet of each foundation, but operational noise would be at levels that could cause behavioral reactions in marine mammals within 120 feet of each turbine. There is the potential for a reduction in effective communication space within the wind farm environment for marine mammals that communicate primarily in frequency bands below 8 kHz (i.e., low-frequency cetaceans). This localized, long-term impact would constitute a **moderate** adverse effect on marine mammals belonging to the low-frequency cetacean hearing group. Operational noise effects on marine mammals in other hearing groups would be **negligible** to **minor** adverse because operational noise overlaps the sound frequencies used for hearing and communication by these species to a lesser degree. It is unknown if operational noise would contribute to displacement effects to marine mammals.

[44] These are 50th and 90th percentile values for monitoring locations RI-1, RI-2, and RI-3, as reported by Kraus et al. (2016).

O&M HRG surveys would also generate impulsive and non-impulsive noise during Project operations. Up to 1,062 linear miles of O&M HRG surveys may be conducted in the RWF and RWEC corridor every year for up to 4 years following Project construction (LGL 2022). As noted above in Section 3.15.2.2.1, BOEM (2021a) determined, and NMFS concurred (NMFS 2021), that HRG survey activities would be unlikely to injure or measurably affect the behavior of ESA-listed marine mammals. This finding can also be applied to non-listed marine mammal species. LGL (2022) estimated the exposure of marine mammal species to 4 years of postconstruction HRG surveys (Table 3.15-11). Overall, noise generated by O&M HRG surveys would likely have a **minor** adverse effect on marine mammals because of the limited exposure and likelihood of full recovery within hours to days.

O&M vessels would also generate periodic, short-term underwater noise impacts with the potential to affect marine mammals. Revolution Wind (Tech Environmental 2023) has estimated that Project O&M would involve up to four CTV and two SOV trips per month for wind farm O&M, or 2,280 vessel trips over the life of the Project. These trips would originate either from an O&M facility located either in Montauk, New York, or Davisville, Rhode Island. One or more CTVs ranging from 62 to 95 feet in length would be purpose built to service the RWF over the life of the Project. SOVs are larger mobile work platforms, on the order of 215 to 305 feet long and 60 feet in beam, equipped with dynamic positioning systems used for more extensive, multi-day maintenance activities (Ulstein 2021). Larger vessels similar to those used for construction could be required for unplanned maintenance, such as repairing scour protection or damaged WTGs. Those activities would occur on an as-needed basis. Additional vessel trips would be required over the life of the Project for seafloor surveys and subsurface inspections. A minimum of three postconstruction seafloor bathymetry surveys would be conducted to assess foundation scour and correct if needed. Project fishery monitoring and benthic habitat monitoring surveys would also be conducted seasonally. Vessels used would be similar to those used for preconstruction HRG surveys.

Table 3.15-11. Estimated Number of Marine Mammals Experiencing Behavioral Effects from Postconstruction High-Resolution Geophysical Survey Activities

Functional Hearing Group	Species	Estimated Number of Individuals Exposed to Behavioral Level Noise Effects Postconstruction HRG Surveys (4 years total)	NMFS Stock Abundance	Number of Individuals Exposed as Percent of Stock Abundance
LFC	Blue whale*	4	402	1.0%
	Fin whale*	8	6,802	0.1%
	Humpback whale	20	1,396	1.4%
	Minke whale	20	21,968	< 0.01%
	North Atlantic right whale*	12	338	3.6%
	Sei whale*	8	6,292	0.1%
MFC	Atlantic spotted dolphin	116	39,921	0.3%
	Atlantic white-sided dolphin	112	93,233	0.1%
	Bottlenose dolphin	116	62,851	0.2%

Functional Hearing Group	Species	Estimated Number of Individuals Exposed to Behavioral Level Noise Effects Postconstruction HRG Surveys (4 years total)	NMFS Stock Abundance	Number of Individuals Exposed as Percent of Stock Abundance
	Common dolphin	2,516	172,974	1.5%
	Pilot whales†	36	68,139	0.1%
	Risso's dolphin	24	35,215	0.1%
	Sperm whale*	8	4,349	0.1%
HFC	Harbor porpoise	132	95,543	0.2%
Phocid pinnipeds	Gray seal	196	27,300	0.7%
	Harbor seal	436	61,336	0.7%

Source: Hayes et al. (2021, 2022); LGL (2022).

* ESA-listed species.

† Group includes both long-finned and short-finned pilot whales. Short-finned pilot whales are considered to be rare within the Lease Area because preferred habitat is not present.

Noise levels generated by the CTVs are expected to have source levels of approximately 160 dB re 1 µPa-m, based on observed noise levels generated by working commercial vessels of similar size and class to the CTVs (Kipple and Gabriele 2003; Takahashi et al. 2019). The SOV would produce similar noise levels to those described for construction vessels by Denes et al. (2021), with an approximate L_{rms} source level of 170 dB re 1 µPa-m. BOEM anticipates that underwater noise generated by CTVs and monitoring vessels would overlap the hearing range and would be audible to most marine mammal species potentially present near the Lease Area. However, the noise levels generated by these smaller Project vessels are below the hearing injury threshold of marine mammals and animals are expected to only have short, transient exposures; therefore, vessel noise from Project monitoring activities is not expected to result in injury-level effects. Noise levels generated by the larger SOVs would be similar to those described in Section 3.15.2.2.1 for Project construction vessels and would result in short-term **minor** adverse noise effects that would occur periodically throughout the life of the Project.

Vessel traffic associated with EPM monitoring could result in brief behavioral responses that would be expected to dissipate once the vessel or the individual has left the area. BOEM expects that these brief responses of individuals to passing vessels would be infrequent. Therefore, noise effects from vessels associated with monitoring efforts would result in **negligible** adverse impacts to marine mammals.

The associated disturbance from decommissioning would be similar to that described above for construction (see Section 3.15.2.2.1), with the exception that pile driving would not be required. While specific decommissioning equipment and methods have not yet been proposed, it is reasonable to assume that the associated impacts would be comparable in magnitude to those resulting from Project construction. One important exception is that impact pile driving would not be required; therefore, underwater noise impacts from decommissioning would be less intense and extensive than those from construction. The monopiles would be cut below the bed surface for removal using a cable saw or abrasive waterjet. Noise levels produced by this type of cutting equipment are generally indistinguishable from engine noise generated by the associated construction vessel (Pangerc et al. 2016). On this basis, short-term effects on marine mammals from decommissioning would be **negligible** adverse because of the limited exposure to noise during decommissioning activities.

<u>Presence of structures:</u> The presence of RWF monopile foundations over the life of the Project would change the offshore environment, and their presence could affect marine mammal behavior; however, the likelihood and significance of these effects are difficult to determine. As discussed in the No Action Alternative, Long (2017) compiled a statistical study of seal and cetacean (including porpoises and baleen whales) behavior in and around Scottish wave energy converter facilities. The study found evidence of displacement during construction, but habitat use appeared to return to previous levels once construction was complete. No observable long-term displacement effects on seals, porpoises, dolphins, or large whales from wave energy converter operations were observed, but these findings may not be applicable to offshore wind structures. Long (2017) also cautioned that observational evidence was limited for certain species and further research would be required to draw a definitive conclusion about operational effects. Delefosse et al. (2017) reviewed marine mammal sighting data around oil and gas structures in the North Sea and found no clear evidence of species attraction or displacement. Other studies have documented apparent changes in marine mammal behavior around wind energy facilities. Some research has suggested that wind farm operations may lead to long-term displacement of species such as harbor porpoise, but the evidence is mixed, and observed changes in abundance could be more indicative of general population trends than an actual wind farm effect (Nabe-Nielsen et al. 2011; Tielmann and Carstensen 2012; Vallejo et al. 2017).

Offshore wind structures are unlikely to interfere with marine mammal movement. The up to 102 RWF monopile foundations proposed under Alternative B would be placed in a grid-like pattern with spacing of approximately 1.0 (0.9 to 1.1) nm between turbines. Based on documented adult lengths (Wynne and Schwartz 1999), the largest NARW (59 feet), fin whale (79 feet), sei whale (59 feet), and sperm whale (59 feet) would fit end-to-end between two foundations spaced at 1 nm 100 times over. This simple assessment of spacing relative to animal size indicates that the physical presence of the monopile foundations is unlikely to pose a barrier to the movement of large marine mammals, and even less likely to impede the movement of smaller marine mammals.

Hydrodynamic and reef effects could theoretically cause indirect effects on marine mammals by changing the distribution and abundance of preferred prey and forage species. Monopile foundations and scour protection would generate an artificial reef effect as surfaces are colonized by habitat-forming organisms (Degraer et al. 2020), likely leading to enhanced biological productivity and increased abundance and concentration of fish and invertebrate resources within and around the Lease Area (Hutchison et al. 2020). This could alter predator-prey interactions with uncertain and potentially beneficial or adverse effects on marine mammals. For example, fish predators like seals and porpoises could benefit from increased biological productivity and abundant concentrations of prey generated by the reef effect (e.g., Russel et al. 2014). Conversely, increased fish biomass around the structures could attract commercial and recreational fishing activity, creating an elevated risk of injury or death from gear entanglement (Moore and van der Hoop 2012). Fisheries interactions are a known source of negative impacts on marine mammals, with estimated global mortality across species exceeding hundreds of thousands of individuals each year (Read et al. 2006; Reeves et al. 2013; Thomas et al. 2016). Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARW and could be a limiting factor in the species' recovery (Knowlton et al. 2012). Project EPMs include inspection and removal of marine debris from foundations (see Table F-1 in Appendix F). This would help to reduce the minimal risk of entanglement in debris caught on structures and provide a mechanism for removing potentially harmful derelict gear from the marine environment.

The RWF would also cause hydrodynamic effects that could influence the distribution and abundance of fish and planktonic prey resources (van Berkel et al. 2020). Offshore wind farms can influence hydrodynamic conditions through two mechanisms: turbulent effects on mixing and stratification patterns caused by current flow around structures in the water column, and changes in surface wave and current patterns caused by wind field effects (i.e., the extraction of wind energy from the atmosphere) (Johnson et al. 2021; van Berkel et al. 2020). Turbulence in the water column created by structure wakes could lead to localized changes in circulation and stratification patterns, with potential implications for primary and secondary productivity and fish distribution. These localized effects would likely be limited to a few hundred to a few thousand feet downcurrent of each foundation.

In contrast, the combined effects of a WTG array on the wind field and surface waves are typically more extensive (Johnson et al. 2021; van Berkel et al. 2020). A growing body of research has demonstrated that offshore wind farms could have observable effects on oceanographic conditions up to tens of miles downfield from wind farm sites (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022; Floeter et al. 2022; Raghukumar et al. 2022), although the extent of these effects and the resulting significance on biological processes are likely to vary considerably between different oceanographic environments (van Berkel et al. 2020). Van Berkel et al. (2020) and Schultze et al. (2020) note that environments characterized by strong seasonal stratification, such as the Mid-Atlantic Bight, are likely to be less sensitive to changes and disruptions to oceanographic processes from wind farm effects. In addition, atmospheric effects are influenced by WTG design. Golbazi et al. (2022) demonstrated that the surface effects of wind wakes from 10 to 15 MW WTGs, the size range being considered for development in the region, were appreciably less extensive than those produced by the smaller turbine designs currently employed in Europe (Akhtar et al. 2022; Christiansen et al. 2022; Daewel et al. 2022). Broadly speaking, the atmospheric effects of wind farms appear to decrease as WTG hub height above the sea surface increases. Collectively, these findings indicate that planned future wind farm development on the Mid-Atlantic OCS are unlikely to produce hydrodynamic effects on the order of those associated with European wind farm development in the southern North Sea (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022).

As discussed in Section 3.6.2.5.2, hydrodynamic effects from RWF development could lead to changes in the dispersal of planktonic eggs and larvae. This suggests that marine mammal species that rely on planktonic prey resources, like NARW, may experience shifts in the availability of preferred resources due to hydrodynamic effects. NARW typically depends on the formation of compressed concentrations of their preferred copepod prey organisms for energy efficient feeding (Baumgartner and Mate 2003; Baumgartner et al. 2017). These compressed concentrations most commonly form during periods of strong stratification and low mixing. Turbulent mixing around wind farm wakes could theoretically scatter these tight copepod concentrations. However, NARWs are most commonly present in southern New England waters during winter months when the water column is well mixed and planktonic organisms are more widely dispersed. NARW may tolerate inefficient feeding during winter to maintain nutritional intake. For example, White and Veit (2020) recently described an association between sea duck distribution and abundant patches of Gammarid amphipods on the western edge of Nantucket Shoals, where NARWs are also found, suggesting that NARW may prey on these amphipods as well in this area. Turbulent mixing effects are likely to be less evident during the well-mixed conditions that predominate during winter.

BOEM conducted a hydrodynamic modeling study to evaluate how wind farm presence could affect the seasonal stratification patterns that contribute to the formation and persistence of the Mid-Atlantic cold pool (Johnson et al. 2021). The findings of this hydrodynamic study and their implications for invertebrates, finfish, and primary and secondary productivity are discussed in detail in Sections 3.6.2.3.2 and 3.13.2.2.2. In summary, the RWF and surroundings are characterized by strong seasonal stratification occurring in summer and early fall, which is expected to limit measurable hydrodynamic effects within the wind farm to within 600 to 1,300 feet downcurrent of each monopile (van Berkel et al. 2020). During winter months, the water column is well mixed, and turbulent mixing effects are likely to be less evident. Localized turbulence and upwelling effects around the monopiles are likely to transport nutrients into the surface layer, potentially increasing primary and secondary productivity. That increased productivity could be partially offset by the formation of abundant colonies of filter feeders on the monopile foundations. As discussed in the No Action Alternative, hydrodynamic effects on wind field and wave energy could influence surface currents at scales on the order of miles to tens of miles, potentially altering the distribution of planktonic organisms (Johnson et al. 2021).

These findings suggest that hydrodynamic effects are unlikely to affect the abundance and availability of zooplankton prey sufficiently to have a measurable effect at the population level, but could alter the distribution of prey at scales ranging from miles to tens of miles. In the absence of other factors, localized impacts on zooplankton and fish abundance and distribution on the scale described are not likely to be biologically significant for marine mammals when considered relative to the broader oceanographic factors that determine primary and secondary productivity in the region and seasonal and interannual variability. However, those changes could become significant if they lead to increased interaction with fisheries or vessel traffic. The likelihood of this type of effect, and the resulting effects to marine mammals, are difficult to predict and therefore unknown.

In summary, long-term reef and hydrodynamic effects resulting from the Proposed Action could result in **minor** beneficial effects on fish-eating marine mammals such as dolphins and seals that benefit from increased prey abundance around the structures. These effects could cause localized changes to prey distribution but do not suggest a notable change in prey availability. It is unclear if these have a significant impact to the ability for marine mammals to feed. Long-term reef and hydrodynamic effects could result in negligible adverse effects on marine mammals that forage on plankton and forage fish. Habitat conditions would be expected to revert back to pre-Project conditions when the Project is decommissioned, or similar conditions within the limits determined by climate change and other ongoing environmental trends. BOEM concludes that the physical presence of RWF monopile foundations would pose a negligible adverse risk of displacement effects on marine mammals by posing a barrier to movement. However, this determination does not consider the potential effects of operational noise, which are localized, long-term impacts and would constitute a **minor** to **moderate** adverse effect on marine mammals belonging to the low-frequency cetacean hearing group. Operational noise effects on marine mammals in other hearing groups would be negligible to minor adverse because the degree to which operational noise overlaps the range of frequencies used for hearing and communication is more limited.

Reef and hydrodynamic effects from the presence of structures would cease when the Project is decommissioned and structures are removed from the environment. Marine mammal prey and forage organisms would redistribute in response to the new baseline ecological and oceanographic conditions. Therefore, the effects of the presence of structures on marine mammals following decommissioning would be **negligible** adverse.

Vessel traffic: Revolution Wind (Tech Environmental 2023) has estimated that Project O&M would involve up to one CTV trip each week and one SOV trip every other week to the RWF over the life of the Project. CTV trips shared between RWF and other offshore energy projects and daughter craft activity could account for an additional 23 vessel trips per year. In total, Project O&M would require an estimated 3,030 vessel trips over the life of the Project. These trips would originate from an O&M facility located either in Montauk, New York, or Davisville, Rhode Island. One or more CTVs ranging from 62 to 95 feet in length would be purpose built to service the RWF over the life of the Project. SOVs are larger mobile work platforms, on the order of 215 to 305 feet long and 60 feet in beam, equipped with dynamic positioning systems used for more extensive, multi-day maintenance activities (Ulstein 2021). Larger vessels similar to those used for construction could be required for unplanned maintenance, such as repairing scour protection or replacing damaged WTGs. Those activities would occur on an as-needed basis. Additional vessel trips would be required over the life of the Project for seafloor surveys and subsurface inspections. A minimum of three postconstruction seafloor bathymetry surveys would be conducted to assess foundation scour and correct if needed. Project fishery monitoring and benthic habitat monitoring surveys would also be conducted annually. Vessels used would be similar to those used for the HRG surveys conducted prior to and during Project construction.

In general, O&M-related vessel activities would represent a small increase in regional vessel traffic compared to existing conditions. Project O&M could involve up to 10 one-way vessel trips between the RWF and O&M facility or other area ports each month. By comparison, hundreds of large vessels and thousands of smaller vessels, many of the latter comparable in size to the CTV, travel through the areas between the wind farm and proposed O&M facility locations on a monthly basis (Section 3.15.2.2.1). O&M vessel use would therefore represent a minimal increase in regional vessel traffic over the life of the facility.

As detailed in Appendix F, all survey vessels would comply with speed restrictions and other minimization measures to minimize risk of collision with marine mammals, making the risk of vessel strikes from survey vessels unlikely. This conclusion is informed by estimated marine mammal densities within the Lease Area and RWEC corridor (Roberts et al. 2016, 2017, 2018, 2020, 2021, 2022), which are generally low in comparison to those in core habitats used by each species. Although species-specific density estimates vary by season, indicating that collision risk would also vary, the vessel strike avoidance measures are designed adaptively to respond to changing conditions as needed to minimize collision risk. Operational conditions combined with planned EPMs (see Appendix F for all vessel strike avoidance measures) would minimize collision risk during construction and installation, O&M, and decommissioning. During periods of low visibility, trained crew would use increased vigilance to avoid marine mammals, including night vision devices and infrared imaging (LGL 2022). BOEM concludes vessel strikes are unlikely to occur and therefore there is no anticipated effect on marine mammals. In the event of an unanticipated vessel strike of a marine mammal, project vessels must immediately cease activities until BOEM is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with all applicable laws (e.g., ESA, MMPA) and COP approval conditions. Overall, effects of vessel traffic on marine mammals from Project O&M and decommissioning would be **negligible** to **minor** adverse because of limited risk exposure and anticipated EPM effectiveness.

3.15.2.3.3 Cumulative Impacts

This section discloses potential impacts to marine mammals associated with future offshore wind development, including the Proposed Action. The cumulative impact analysis for the Proposed Action includes Alternative B, other planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects. Cumulative impacts to marine mammals under the Proposed Action presented herein would be incremental to and would compound the impacts of baseline conditions on each marine mammal population considered in this EIS (see Table 3.15-2).

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: The Proposed Action would result in localized, temporary, **negligible** adverse impacts to marine mammals through an estimated 7,213 acres of anchoring and cabling-related seafloor disturbance and associated increased suspended sedimentation within the GAA. BOEM estimates a cumulative total of 105,390 acres of cabling seafloor disturbance and 11,631 acres of anchoring disturbance for the Proposed Action plus all other future offshore wind projects in the GAA. No population-level effects on marine mammals are expected from reduced water quality. However, there could be temporary displacement of marine mammals from preferred habitats, especially during construction activities, due to increased vessel activity. Vessel anchoring and cable emplacement during construction and installation, O&M, and decommissioning are not anticipated to involve equipment, lines, or rigging that could pose a potential entanglement risk to marine mammals. Therefore, the Proposed Action combined with past, present, and reasonably foreseeable activities would result in **negligible** to **minor** adverse cumulative effects on marine mammals.

Climate change: Global climate change is altering water temperatures, circulation patterns, and oceanic chemistry at global scales. Several marine species, including fish, invertebrates, and zooplankton—prey resources for marine mammals—have shifted northward in distribution over the past several decades (NOAA 2021b). Ocean acidification, also a function of climate change, has negatively affected some zooplankton species (PMEL 2020). Marine mammals are modifying their behavior and distribution in response to these broader observed changes (Davis et al. 2017, 2020; Hayes et al. 2020, 2021, 2022). These trends are expected to continue, with complex and potentially adverse consequences for many marine mammal species. The Proposed Action in combination with existing and planned future actions would result in the development of a network of artificial reefs distributed across the GAA. The biological hotspots created by these artificial reefs are expected to influence fish and invertebrate community structure at local scales and could also influence the ability of certain fish and invertebrate species to shift and expand their ranges in response to climate change. This could in turn result in cumulative effects on marine mammals that could be beneficial or adverse depending on a number of complex factors. The nature and potential significance of these effects to marine mammals are unknown but are likely to range from **minor** to **moderate** adverse. Effects to specific marine mammal species, such as NARW, would depend on how climate change affects habitat suitability and forage availability, the status and resilience of affected populations, and the ability to adapt to these impacts.

Noise: BOEM estimates that a cumulative total of 3,190 offshore WTGs and OSS foundations would be developed in the GAA for marine mammals between 2022 and 2030.While the number and distribution of potential UXO encounters is not currently known, it is likely that a least some UXO detonations would be required. Device size is also not currently known but would likely fall within a similar range of impacts to those described for construction of the Proposed Action.

Section 3.15.1.1 provides an overview of potential concurrent construction activities in the GAA. Each action would generate underwater noise of similar type and intensity as the Proposed Action, scaled in extent to the size of each facility. Each future project would be anticipated to result in adverse effects on individual marine mammals, up to and including PTS, and TTS, auditory masking and behavioral impacts. Construction noise would also contribute to short-term displacement effects, as described above.

All future actions would be subject to the same independent NEPA analysis and regulatory approvals as the Proposed Action. BOEM would require all projects to incorporate the same types of EPMs included in the Proposed Action to avoid and minimize harmful noise effects. While these measures would avoid and minimize impacts to marine mammals to the greatest extent practicable, some unavoidable impacts on individuals are likely to occur. The impacts of each project would result in **minor** to **moderate** adverse effects on marine mammals. Cumulative noise effects on marine mammal species would depend on the number of individual animals exposed to injury and behavioral level noise effects, the significance of those effects to survival and reproductive success, and the status of the affected population. BOEM anticipates that future MMPA approvals would consider the known status of individual marine mammal stocks and populations, indirectly incorporating the potential combined effects of future projects. Therefore, BOEM concludes that the cumulative effects of construction noise on marine mammals would be **moderate** adverse because of the potential for PTS, TTS, and behavioral impacts during construction activities. NARW could be an exception to this determination because of its perilous population status. Hearing-related injury to even one individual that results in reduced reproductive fitness could contribute to ongoing downward trends in population viability. Should such impacts occur, they could constitute a greater than moderate adverse impact on this species. However, the EPMs proposed for this project should effectively avoid this level of impact.

As discussed in Sections 3.15.1.1 and 3.15.2.2, operational noise from offshore wind turbines is expected to be limited in intensity and extent. Operational noise exceeding the 120 dB re 1 μPa behavioral harassment threshold would be limited to within approximately 35 to 165 feet of each turbine (per NOAA 2018), although detectable noise above ambient levels could extend up to approximately 1,200 feet. The Proposed Action combined with all existing and planned future actions would place over 3,000 noise-generating WTG foundations in the RI/MA and MA WEAs. These structures would contribute to and potentially increase ambient noise within each WEA, albeit at levels generally not associated with adverse effects on marine mammals. However, the 120 dB re 1 μPa threshold may not adequately represent the potential for adverse effects of chronic noise exposure (e.g., Cholewiak et al. 2018; Hatch et al. 2012; Jensen et al. 2009; Putland et al. 2017). While the potential for broader effects is unclear, BOEM concludes that the cumulative effects of low-level operational noise could raise to the level of **minor** adverse for certain marine mammal species.

Presence of structures: BOEM estimates a cumulative total of up to 3,190 offshore WTGs and OSS foundations in the GAA for marine mammals between 2022 and 2030. This total comprises foundations from the Proposed Action and up to 3,088 foundations associated with existing (BIWF) and planned state and federal offshore wind energy projects on the OCS between North Carolina and Maine (see Appendix E3, Table E3-1).

Project construction is likely to result in short-term displacement effects on marine mammals from the areas affected by disturbance from vessel activity, foundation installation, HRG surveys, and related activities. Several projects are expected to be constructed concurrently, potentially resulting in individual marine mammals being exposed to multiple episodes of habitat displacement. BOEM anticipates that the construction schedules for future wind projects would employ the same types of timing restrictions to protect NARW as those included in the Proposed Action, with modifications as needed to adapt to ongoing shifts in the seasonal distribution of this species (e.g., Davis et al. 2017, 2020). However, timing restrictions for NARW would not be protective for all marine mammal species. It is anticipated that future wind projects would also employ a similar range of EPMs to avoid and minimize impacts to marine mammals, but some level of short-term displacement is likely to occur, and some individual animals are likely to be exposed to multiple episodes of displacement. The significance of these potential impacts is unclear, but when all protective measures are considered, cumulative effects are likely to range from **negligible** to **moderate** adverse. Impacts to each marine mammal species, such as NARW, are uncertain and would depend on several factors, including species-specific displacement effects, the nature and extent of effects to forage resources, and, the status and sensitivity of the affected population to effects to individuals.

BOEM anticipates that future wind projects within the RI/MA WEA would be constructed using 1 × 1–nm grid spacing, as does the Proposed Action. Foundations spaced at 1 × 1 nm are unlikely to pose a barrier to movement for even the largest marine mammal species. However, the broadscale development of offshore energy structures would introduce an extended network of biologically productive artificial reefs, most generating low levels of non-impulsive sound that are detectable to marine mammals within a few hundred feet. While the individual effects of each turbine would be **minor** adverse, the broader implications of these habitat changes for marine mammals are unclear. Displacement effects that result in increased interactions between vulnerable populations of marine mammals and commercial shipping and/or fishing activity could have significant long-term cumulative effects. Given these uncertainties, the potential for displacement and level of effects is unknown, but there is currently no basis to conclude that these impacts would result in greater than minor adverse long-term effects on any species.

The abundance of fish and invertebrate prey resources created by the artificial reef effect are likely to attract predatory marine mammals, particularly seals (e.g., Russel et al. 2014) and potentially dolphins and porpoises. Increased fish biomass around the structures could attract commercial and recreational fishing activity, leading to increased interactions between humans and marine mammals. BOEM anticipates that future projects would perform regular inspections to identify and remove derelict fishing gear and other marine debris from offshore structures, reducing associated risks to marine mammals.

The new wind energy structures would also cause hydrodynamic effects. Marine mammal species that rely on planktonic prey resources, like NARW, may experience shifts in the availability of preferred resources due to these hydrodynamic effects. NARW typically depends on the formation of thin vertically compressed layers of copepods to efficiently feed (Baumgartner and Mate 2003; Baumgartner et al. 2017). However, during the winter months, when they are primarily present in southern New England waters and the water column is well mixed, they may tolerate inefficient feeding simply to gain some nutrition. For example, White and Veit (2020) recently described an association between sea duck distribution and abundant patches of Gammarid amphipods on the western edge of Nantucket Shoals, suggesting that right whales also present there may prey on these amphipods as well. Thus, the potential hydrodynamic effects discussed in the subsequent paragraphs may influence the availability of already limited prey resources for NARW.

A growing body of research has demonstrated that offshore wind farms could have observable effects on oceanographic conditions up to tens of miles downfield from wind farm sites (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022; Floeter et al. 2022; Raghukumar et al. 2022), although the extent of these effects and resulting significance on biological processes are likely to vary considerably between different oceanographic environments (van Berkel et al. 2020). In addition, atmospheric effects are influenced by WTG design. Golbazi et al. (2022) demonstrated that the surface effects of wind wakes from 10 to 15 MW WTGs, the size range being considered for development in the region, were appreciably less extensive than those produced by the smaller turbine designs currently employed in Europe (Akhtar et al. 2022; Christiansen et al. 2022; Daewel et al. 2022). Broadly speaking, the atmospheric effects of wind farms appear to decrease as WTG hub height above the sea surface increases. Collectively, these findings indicate that planned future wind farm development on the Mid-Atlantic OCS are unlikely to produce hydrodynamic effects on the order of those associated with European wind farm development in the southern North Sea (e.g., Christiansen et al. 2022; Daewel et al. n.d. [2023]; Dorell et al. 2022).

As discussed in the previous section, the Proposed Action is not anticipated to result in additive hydrodynamic effects. However, broader scale development of contiguous projects could have more extensive effects. For example, Afsharian et al. (2020) modeled the potential effects from installation of over 400 offshore wind turbines in Lake Erie and determined that their cumulative effect on wind energy could disrupt circulation patterns and affect seasonal stratification and water temperatures over broad scales. However, these findings may not be applicable to the open ocean where circulation patterns are strongly influenced by tides and ocean currents.

At present, currently available information suggests that hydrodynamic effects of foundation structures are likely to be localized and not additive when spaced at 1 × 1 nm in environments with strong seasonal stratification (van Berkel et al. 2020). Recent modeling of hydrodynamic effects suggests that surface currents could be affected by the presence of multiple wind farms potentially impacting the distribution of larvae (Johnson et al. 2021). There is insufficient information to determine if this conclusion is valid for broader scale development at the levels planned within the GAA. Therefore, at this time, there is no basis to conclude that the cumulative hydrodynamic impacts of Proposed Action in combination with planned future actions would have a measurable effect on marine mammals and their prey and forage species.

In summary, the cumulative effects of long-term habitat alteration and hydrodynamic impacts on marine mammals are unclear, could be beneficial or adverse, and could range from **negligible** to **moderate** adverse. Effects to specific species, such as NARW, would depend on several factors including the nature and distribution of changes in forage availability, resulting effects on individual survival and reproductive fitness, and the status and sensitivity of the affected population to these impacts. Although the type and magnitude of effect from displacement and shifts in prey resources due to the presence of structures are largely unknown, the possibility of changes in distribution relative to commercial fishing activity and increased interaction with fishing gear poses the potential for increased risk of entanglement. Should such changes occur, increased risk of entanglement would constitute a **minor** to **moderate** adverse effect on marine mammals, because this stressor is a documented source of injury and mortality. Effects to each marine mammal species would depend on the number of individual animals exposed to entanglement effects, the nature of the impact (i.e., injury or mortality), and the status and sensitivity of the affected population to these impacts. In the case of NARW, the potential for increased exposure to entanglement could pose a significant risk as injury or mortality that removes even one juvenile or reproductive age individual from the population would constitute a greater than moderate effect. It is important to stress that the likelihood of this level of effect is unclear because it is not known if the presence of structures would displace NARW and whether displacement would lead to increased fishing gear exposure. These potential long-term impacts would persist until decommissioning is complete and structures are removed. EPMs would help to offset the potential impact of entanglement within derelict fishing gear or marine debris.

Vessel traffic: BOEM estimates that, cumulatively, up to 262 construction vessels could be active within the GAA between 2022 and 2030. As discussed above for Project construction, the majority of vessel operations would be expected to occur at speeds of less than 10 knots. In addition, BOEM anticipates that future projects would adhere to mandatory and voluntary vessel speed restrictions in posted DMAs and SMAs and would implement EPMs similar to those described for the Proposed Action (see Appendix F, Table F-1) to avoid marine mammal collisions. BOEM has concluded that these measures would effectively avoid all but minor adverse impacts on sensitive species such as NARW and minimize risk of vessel collisions to other marine mammal species. Therefore, the cumulative effects of increased vessel traffic on marine mammals would range from **negligible** to **moderate** adverse.

3.15.2.3.4 Conclusions

Impacts of Alternative B, the Proposed Action. Project construction would primarily result in noise that would disturb marine mammals and potentially result in permanent impacts (i.e., PTS). EPMs would minimize noise exposure such that any PTS of NARWs would be avoided and, for all marine mammals, the severity of any behavioral responses would be minimized. Therefore, the incremental impact of the Proposed Action when compared to the No Action Alternative would be minor for NARWs from construction given the likely outcome of noise exposure would be a deflection, but not abandonment, of their migratory path. More severe impacts on marine mammals, such as mortality or serious injury from vessel strikes, UXO detonation, and entanglement, are not anticipated due to the EPMs and additional measures that would be required as part of the environmental permitting processes. The incremental impact of the Proposed Action when compared to the No Action Alternative would be **minor** to **moderate** adverse for mysticetes, with moderate adverse impacts for humpback whale due to permanent hearing injury to individuals and for NARW due to potential exposure of several individuals to temporary behavioral disturbance in potentially important seasonal foraging habitats. Impacts to odontocetes would range from **minor** to **moderate**, with moderate impacts to harbor porpoise from permanent hearing injury to individuals. Pinnipeds would experience **minor** to **moderate** impacts to individuals from behavioral exposure and hearing injury to individuals. Mortality and non-auditory injury would not occur as a result of UXO detonation, only a few marine mammals of select species are anticipated to incur PTS incidental to pile driving and UXO detonation, vessel strike risk is very low and not anticipated, and accidental spills are also not anticipated. Because of the population status of NARW, the Project includes EPMs specifically designed to avoid and minimize adverse effects on this species. Implementation of these EMPs would effectively avoid greater than moderate effects on this species. Given this, the overall impact of the Proposed Action alone on marine mammals would be **moderate** adverse.

When including the baseline status of marine mammals into the impact findings and considering all phases of the Project, the impacts of the Proposed Action on NARW would be long term and **major** (primarily due to ongoing vessel strike and entanglement), and long term and **moderate** for other mysticetes. Impacts of the Proposed Action on odontocetes and pinnipeds would be long term and **minor** to **moderate**. Some **minor beneficial** impacts to certain odontocetes and pinnipeds could be realized through artificial reef effects. Beneficial effects, however, may be offset given the increased risk of entanglement due to derelict fishing gear and marine debris captured by offshore wind structures.

Cumulative Impacts of Alternative B, the Proposed Action. Existing environmental trends and ongoing activities would continue, and mysticetes, odontocetes, and pinnipeds would continue to be affected by natural and human-caused IPFs. Planned activities would contribute to impacts on marine mammals. Although injury or mortality of individuals may occur, long-term population-level effects are not anticipated for marine mammals (with the exception of NARW). Underwater noise impacts, vessel activity (vessel collisions), entanglement, and seabed disturbance, primarily from non–offshore wind activities, would result in **moderate** impacts. Accidental releases and discharges, EMF, the presence of structures, cable emplacement and maintenance, port utilization, and lighting associated with offshore wind activities would be implemented with measures to minimize impacts on marine mammals. Incremental impacts contributed by the Proposed Action to the cumulative impact on marine mammals would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts for mysticetes, odontocetes, and pinnipeds in the GAA from the Proposed Action would be **moderate** to **major.** Long-term impacts to NARW would be **major** (due principally to baseline conditions), **moderate** for other mysticetes, and **minor** to **moderate** for odontocetes and pinnipeds. Impacts from the Proposed Action are not anticipated to substantially contribute to **major** long-term cumulative impacts for NARW. Some **minor beneficial** impacts to certain odontocetes and pinnipeds could be realized through artificial reef effects.

3.15.2.4 Alternatives C, D, E, and F

Under Alternatives C, D, E, and F, baseline conditions for marine mammals (see Section 3.15.1) would continue to follow current regional trends within the GAA. The impacts of existing conditions on marine mammals are described and analyzed in Appendix E1. The impacts of each IPF from the construction and installation, O&M, and conceptual decommissioning of Alternatives C, D, E, and F would be incremental to and would compound the impacts of baseline conditions on each marine mammal population considered in this EIS (see Table 3.15-2). These effects are described below.

3.15.2.4.1 Construction and Installation

Offshore Activities and Facilities

Noise: Construction of Alternatives C through F would result in similar underwater noise impacts on marine mammals to those described for the Proposed Action in Section 3.15.2.2.1, but those impacts would be reduced in extent and duration because fewer structures would be installed. Reducing the number of structures is also expected to reduce the required extent of HRG surveys relative to the Proposed Action. It is assumed that 3,547 linear miles and 82 days of HRG survey effort would be required for the RWEC and OSS-link, plus 50 survey miles per linear mile of IAC cable at 43 miles of survey effort per day. The alternatives therefore range from 7,386 to 7,616 survey miles over 170–175 days for Alternative C, 7,951 to 8,846 survey miles over 183–204 days for Alternative E, and 9,279 to

10,142 survey miles over 213–233 days for Alternative E. Thus, the extent of HRG surveys is reduced proportional to the total number of structures proposed for each configuration. As of February 2023, 16 UXOs have been identified in the RWEC corridor (see Figure 2.1-10). Revolution Wind has determined that all 16 devices can be safely avoided by shifting the cable route within the approved installation corridor without the need for detonation (Orsted 2023). However, it is possible that additional devices of unknown size and location could be discovered during preconstruction surveys or construction that cannot be avoided or safely relocated. Impacts to marine mammals from HRG surveys and UXO detonation are considered to be similar in magnitude and general scale across all alternatives.

Differences in extent and duration of potential noise exposure from impact pile driving activities between the Proposed Action and the different configurations proposed for Alternatives C through E are summarized in Tables 3.15-12 through 3.15-14. These tables display the number of structures installed and estimated days of pile-driving activity required to construct each alternative. Extent and duration of potential noise exposure are proportional to the number of WTGs proposed; fewer WTGs would result in a smaller extent and shorter duration of impacts. For example, the two configurations of Alternative C and Alternative E1 would involve noticeably fewer days of pile driving than the Proposed Action and most configurations of Alternative D. While fewer individual marine mammals could be exposed to underwater noise impacts under these alternatives, the likelihood of at least some individuals being exposed to permanent injury remains. Accordingly, the impacts of this IPF would be noticeably reduced under these alternatives, the overall impacts would be similar in magnitude and general scale to those resulting from the Proposed Action. Adverse noise effects on marine mammals from each alternative for the duration of construction activities would likewise vary between species ranging from **minor** to **moderate** adverse. The potential use of larger capacity WTGs under Alternative F could result in more extensive operational noise impacts than the Proposed Action, but insufficient information is available to characterize differences in effect.

Table 3.15-12. Comparison of Maximum Underwater Noise Injury and Behavioral Effects Exposure Extent and Duration (number of sites/days) by Marine Mammal Hearing Group from Revolution Wind Farm WTG and OSS Foundation Installation, Proposed Action, and Proposed Configurations for Alternative C*

Noise Exposure Type	Hearing Group	Threshold Distance for WTGs (feet)†	Threshold Distance for OSSs (feet)†,§	Proposed Action	Alternative C1	Alternative C2
Peak injury	LFC	< 33	< 33	102 sites/ 35 days	66 sites/ 23 days	67 sites/ 23 days
	MFC	–	–			
	HFC	525	361			
	Phocids	–				
Cumulative injury	LFC	4,954–8,727	3,084–5,873			
	MFC	0–66	–			
	HFC	4,396	2,723			
	Phocids	787–1,444	33–1,214			
Behavioral effects	LFC	11,909–12,336	11,516–11,877			
	MFC	0–12,041	0–11,909			
	HFC	11,877	11,483			
	Phocids	11,909–12,467	11,549–12,303			

* Installation scenario for a 12-m monopile is 10,740 strikes/pile at an installation rate of three piles/day. Installation scenario for a 15-m monopile is 11,563 strikes/pile at an installation rate of one pile/day. All piles installed with a 4,000-kJ hammer with an attenuation system achieving 10 dB sound source reduction.

† Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur. Values are the range of threshold distances for monopile installation modeled by Kusel et al. (2023) across modeled sites during summer conditions.

§ Threshold distances for OSSs apply to two of the structures identified for each of the alternatives presented.

Table 3.15-13. Comparison of Maximum Underwater Noise Injury and Behavioral Effects Exposure Extent and Duration (number of sites/days) by Marine Mammal Hearing Group from Revolution Wind Farm WTG and OSS Foundation Installation, Proposed Action, and Proposed Configurations for Alternative D*

Exposure Type	Hearing Group	Threshold Distance for WTGs (feet)†	Threshold Distance for OSSs (feet)†,§	Proposed Action	Alternative D1	Alternative D2	Alternative D3	Alternative D1+D2	Alternative D1+D3	Alternative D2+D3	Alternative D1+D2+D3
Peak injury	LFC	< 33	< 33	102 sites/ 35 days	95 sites/ 33 days	94 sites/ 33 days	95 sites/ 33 days	87 sites/ 30 days	88 sites/ 31 days	87 sites/ 30 days	80 sites/ 28 days
	MFC	–	–								
	HFC	525	361								
	Phocids	–									
Cumulative injury	LFC	4,954–8,727	3,084–5,873								
	MFC	0–66	–								
	HFC	4,396	2,723								
	Phocids	787–1,444	33–1,214								
Behavioral effects	LFC	11,909–12,336	11,516–11,877								
	MFC	0–12,041	0–11,909								
	HFC	11,877	11,483								
	Phocids	11,909–12,467	11,549–12,303								

* Installation scenario for a 12-m monopile is 10,740 strikes/pile at an installation rate of three piles/day. Installation scenario for a 15-m monopile is 11,563 strikes/pile at an installation rate of up to two piles/day. All piles installed with a 4,000-kJ hammer with an attenuation system achieving 10 dB sound source reduction.

† Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur. Values are the range threshold distances for monopile installation modeled by Kusel et al. (2023) across modeled sites and seasonal conditions.

§ Threshold distances for OSSs apply to two of the structures identified for each alternative presented.

Table 3.15-14. Comparison of Maximum Underwater Noise Injury and Behavioral Effects Exposure Extent and Duration (number of sites/days) by Marine Mammal Hearing Group from Revolution Wind Farm WTG and OSS Foundation Installation, Proposed Action, and Proposed Configurations for Alternative E*

Noise Exposure Type	Hearing Group	Threshold Distance for WTGs (feet)[†]	Threshold Distance for OSSs (feet)[†,§]	Proposed Action	Alternative E1	Alternative E2
Peak injury	LFC	< 33	< 33	102 sites/ 35 days	66 sites/ 23 days	83 sites/ 29 days
	MFC	–	–			
	HFC	525	361			
	Phocids	–				
Cumulative injury	LFC	4,954–8,727	3,084–5,873			
	MFC	0–66	–			
	HFC	4,396	2,723			
	Phocids	787–1,444	33–1,214			
Behavioral effects	LFC	11,909–12,336	11,516–11,877			
	MFC	0–12,041	0–11,909			
	HFC	11,877	11,483			
	Phocids	11,909–12,467	11,549–12,303			

* Installation scenario for a 12-m monopile is 10,740 strikes/pile at an installation rate of three piles/day. Installation scenario for a 15-m monopile is 11,563 strikes/pile at an installation rate of up to two piles/day. All piles installed with a 4,000-kJ hammer with an attenuation system achieving 10 dB sound source reduction.

† Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur. Values are the range threshold distances for monopile installation modeled by Kusel et al. (2023) across modeled sites and seasonal conditions.

§ Threshold distances for OSSs apply to two of the structures identified for each of the alternatives presented.

3.15.2.4.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Presence of structures: The presence of WTG and OSS monopile foundations associated with Alternatives C through F would result in similar impacts to marine mammals as those described for the Proposed Action in Section 3.15.2.2.2, but those impacts would be reduced in extent and would vary depending on the alternative selected. Refer to Tables 3.6-17 through 3.6-19 in Section 3.6.2.4.2 for a summary of the number of structures under each proposed configuration of Alternatives C through F. As stated, Alternative F would employ one of the proposed configurations of Alternatives C through E using higher capacity WTGs. Aside from increased WTG capacity, all other features and impacts of Alternative F would be the same as those described for the selected configuration.

Over the life of the Project, the WTG and OSS foundations and associated scour protection would alter the offshore environment inhabited by marine mammals. Their presence could affect marine mammal behavior and indirectly affect the distribution and abundance of prey and forage species; however, the significance of these effects to a specific marine mammal species, such as NARW, is uncertain and would depend on the nature, extent, and significance of effects to forage species. For example, hydrodynamic effects from the presence of structures could alter the distribution of zooplankton and forage fish resources for baleen whales, leading those species to alter foraging patterns in response. These effects would likely influence the distribution of marine mammal forage species at a broad scale, but as discussed in Section 3.15.2.2.2, shifts in forage abundance and distribution would be expressed at smaller scales within this broader range. There is no basis to conclude that hydrodynamic effects would negatively affect the abundance and availability of prey species for marine mammals. The presence of structures and localized changes in forage species distribution could theoretically lead to displacement some marine mammal species and the potential for increased interaction with fisheries. Should such effects occur, they could lead to greater than negligible impacts on certain marine mammal species. However, insufficient information is available to determine if displacement effects are likely to occur and whether those effects would be biologically significant.

Impacts from the presence of structures are expected to vary in relation to the total number of foundations proposed (i.e., fewer structures would result in less extensive impacts). For example, both configurations of Alternative C and Alternative E1 propose noticeably fewer WTG and OSS foundations compared to the Proposed Action and most configurations of Alternative D. Therefore, these alternatives would be expected to produce noticeably reduced impacts from this IPF by comparison. In general, presence of structures effects on marine mammals under Alternatives C through F would likely be less extensive compared to those resulting from the Proposed Action. Reef effects would be reduced commensurate with the number of foundations constructed under each alternative configuration. At present, insufficient information is available to determine if differences in Project configuration between alternatives, specifically where foundations are located relative to sensitive benthic habitats, would contribute to a measurable difference in reef effects on marine mammals beyond those resulting from a simple reduction in the number of structures. As stated in Section 3.15.2.2.3, hydrodynamic effects are likely to lead to localized changes in the distribution of phytoplankton and forage fish prey for some marine mammal species, but these changes are unlikely to be biologically significant. Therefore, while Alternatives C through F would likely alter and reduce the extent of measurable hydrodynamic effects, those effects are likely to remain biologically insignificant. Following decommissioning and removal of the structures from the water column, the habitat would be expected to recover to conditions comparable to the environmental baseline for the surrounding habitats.

While certain alternative configurations would result in a noticeable reduction in the number of structures in the marine environment, it is not clear that this would result in a biologically significant difference in the effects of this IPF relative to the Proposed Action. It is not currently known if the presence of structures would result in displacement effects; therefore, it is not possible to determine if reducing the number of structures and altering their configuration would reduce displacement effects. Therefore, while Alternatives C through F would reduce the extent of reef and hydrodynamic effects, the overall impacts to marine mammals would be similar in magnitude and general scale to those resulting from the Proposed Action. On this basis, impacts from the presence of structures on marine mammals for Alternatives C through F are expected to range from **negligible** adverse to **minor** beneficial for the life of the Project. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including species-specific displacement effects, the nature and extent of effects to forage resources, and the status and sensitivity of the affected population to effects to individuals.

3.15.2.4.3 Cumulative Impacts

Offshore Activities and Facilities

The cumulative impacts analysis for Alternatives C, D, E, and F is provided in Table 3.15-4.

3.15.2.4.4 Conclusions

Impacts of Alternatives C, D, E, and F. As discussed in above sections, the anticipated impacts from these alternatives would reduce the number of WTGs and their associated IACs by approximately 10% to 43%, which would in turn result in an incremental reduction in effects on marine mammals from certain construction and installation, O&M, and conceptual decommissioning impacts. However, BOEM anticipates that any incremental reduction in impacts would not change the resulting effects on marine mammals to the extent necessary to alter the impact-level conclusions for any impact mechanism. The incremental impacts of Alternatives C, D, E, and F, when each is compared to the No Action Alternative, would be similar as the Proposed Action (i.e., **moderate** for NARWs, **minor** to **moderate** for other mysticetes, **minor** to **moderate** for odontocetes, and **minor** to **moderate** for pinnipeds) because, with the implementation of EPMs, mortality and non-auditory injury would not occur as a result of UXO detonation, only a few marine mammals of select species are anticipated to incur PTS incidental to pile driving and UXO detonation, vessel strike risk is very low and not anticipated, and accidental spills are also not anticipated.

The impacts resulting from Alternatives C, D, E, and F individually, when including the baseline status of marine mammals into the impact findings and considering all phases of the Project, would be similar to those of the Proposed Action and would be **minor** to **moderate** for mysticetes except for the NARW, which would be **major**. BOEM anticipates that the impacts resulting from the Proposed Action would be **minor to moderate** for odontocetes and pinnipeds and could include **minor beneficial** impacts. Adverse impacts are expected to result mainly from underwater noise (e.g., UXO detonations and impact pile driving) and increased vessel traffic potentially leading to vessel strikes. Beneficial impacts for odontocetes and pinnipeds are expected to result from the presence of structures.

Cumulative Impacts of Alternatives C, D, E, and F. The incremental impacts contributed by Alternatives C, D, E, and F to the cumulative impacts on marine mammals would be similar to those of the Proposed Action and would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts of Alternatives C, D, E, and F when each is combined with ongoing and planned activities, including offshore wind, would be the same level as under the Proposed Action: **major** for NARW and **minor** to **moderate** for all other marine mammals. Some **minor beneficial** impacts to certain odontocetes and pinnipeds could be realized through artificial reef effects.

3.15.2.5 Alternative G: Impacts of the Preferred Alternative on Marine Mammals

Under Alternative G, baseline conditions for marine mammals (see Section 3.15.1) would continue to follow current regional trends within the GAA. The impacts of existing conditions on marine mammals are described and analyzed in Appendix E1. The impacts of each IPF from the construction and installation, O&M, and conceptual decommissioning of Alternative G would be incremental to and would compound the impacts of baseline conditions on each marine mammal population considered in this EIS (see Table 3.15-2). These effects are described below.

3.15.2.5.1 Construction and Installation

Offshore Activities and Facilities

Noise: Construction of Alternative G would result in similar underwater noise impacts on marine mammals to those described for the Proposed Action in Section 3.15.2.3.1, but those impacts would be reduced in extent and duration because fewer structures would be installed. Reducing the number of structures could also reduce the required extent of HRG surveys relative to the Proposed Action, but BOEM has insufficient information to determine if this is the case. As of February 2023, 16 UXOs have been identified in the RWEC corridor. Revolution Wind has determined that all 16 devices can be safely avoided by shifting the cable route within the approved installation corridor without the need for detonation (Orsted 2023). However, it is possible that additional devices of unknown size and location could be discovered during preconstruction surveys or construction that cannot be avoided or safely relocated. Therefore, impacts to marine mammals from HRG surveys and UXO detonation are considered to be the same as for the Proposed Action.

Differences in the extent and duration of potential noise exposure from impact pile-driving activities between the Proposed Action and Alternative G are summarized in Table 3.15-15. This table displays the number of structures installed and estimated days of pile-driving activity required to construct the alternative. Extent and duration of potential noise exposure are proportional to the number of WTGs proposed; fewer WTGs would result in a smaller extent and shorter duration of impacts. While fewer individual marine mammals could be exposed to underwater noise impacts under these alternatives, the likelihood of at least some individuals being exposed to permanent injury remains. Accordingly, the impacts of this IPF would be noticeably reduced under this alternative, but the overall impacts would be similar in magnitude and general scale to those resulting from the Proposed Action. Adverse noise effects on marine mammals from Alternative G for the duration of construction activities would likewise vary between species, ranging from **minor** to **moderate** adverse.

Table 3.15-15. Comparison of Maximum Underwater Noise Injury and Behavioral Effects Exposure Extent and Duration (number of sites/days) by Marine Mammal Hearing Group from Revolution Wind Farm WTG and OSS Foundation Installation, Proposed Action, and Proposed Configuration for Alternative G*

Noise Exposure Type	Hearing Group	Threshold Distance for WTGs (feet)†	Threshold Distance for OSSs (feet)†,§	Proposed Action	Alternative G	Alternatives G1–G3
Peak injury	LFC	< 33	< 33	102 sites/ 35 days	81 sites/ 29 days	67 sites/ 25 days
	MFC	–	–			
	HFC	525	361			
	Phocids	–				
Cumulative injury	LFC	4,954–8,727	3,084–5,873			
	MFC	0–66	–			
	HFC	4,396	2,723			
	Phocids	787–1,444	33–1,214			
TTS and behavioral effects	LFC	11,909–12,336	11,516–11,877			
	MFC	0–12,041	0–11,909			
	HFC	11,877	11,483			
	Phocids	11,909–12,467	11,549–12,303			

* Installation scenario for a 12-m monopile is 10,740 strikes/pile at an installation rate of three piles/day. Installation scenario for a 15-m monopile is 11,563 strikes/pile at an installation rate of one pile/day. All piles installed with a 4,000-kJ hammer with an attenuation system achieving 10 dB sound source reduction.

† Threshold distances are the distance in feet from the sound source where the identified type of exposure could occur. Values are the range threshold distances for monopile installation modeled by Kusel et al. (2023) across modeled sites during summer conditions.

§ Threshold distances for OSSs apply to two of the structures identified for each of the alternatives presented.

Vessel traffic: Alternative G would result in similar vessel traffic impacts on marine mammals to those described in Section 3.15.2.3.1. An estimate of vessel trips associated with Alternative G construction is not available; however, it is expected to be slightly less than the Proposed Action with effects commensurate with the reduction in vessel activities associated with 21 or 35 (depending on the configuration) fewer foundations.

Vessel collisions are a key source of mortality and serious injury for many marine mammal species (Hayes et al. 2021, 2022; Laist et al. 2001; Rockwood et al. 2017; Schoeman et al. 2020), indicating the importance of protective measures to minimize risks to vulnerable species. If a vessel strike does occur, the impact on marine mammals would range from **negligible** to **moderate** adverse, considering the application of project-specific EPMs. The applicant has committed to a range of EPMs to avoid vessel collisions with marine mammals (see Appendix F, Table F-1). These include adherence to NOAA guidance for collision avoidance and a combination of additional measures, including approved speed restrictions for all vessels within marine mammal SMAs and DMAs, and adherence to additional mitigation measures, as identified in Appendix F, Table F-1. All vessel crews would receive training to ensure that these EPMs are fully implemented for vessels in transit. Once on station, the construction vessels either remain stationary when installing the monopiles and WTG/OSS equipment or move slowly when traveling between foundation locations. Cable laying and HRG survey vessels also move slowly, with typical operational speeds of less than 1 knot and approximately 4 knots, respectively, and present minimal risk of collision-related injury.

The densities of the most common species of marine mammals likely to occur in the RWF Lease Area and RWEC route are generally low based on monthly mean density estimates developed by Roberts et al. (2016, 2017, 2018, 2020, 2021). Density and occurrence in and near the Lease Area vary by season and species; however, vessel strike avoidance measures would be implemented to minimize risk across the range of seasonal densities. Operational conditions combined with planned EPMs would minimize collision risk during construction and installation. Additional mitigation measures agreed upon through agency consultation would further reduce this risk (see Appendix F for all vessel strike avoidance measures). During periods of low visibility, trained crew would use increased vigilance to avoid marine mammals. Because vessel strikes are not an anticipated outcome given the relatively low number of vessel trips and EPMs to avoid encountering marine mammals, BOEM concludes vessel strikes are unlikely to occur. Therefore, there is no anticipated effect on marine mammals, and collision effects would be **negligible** adverse during Project construction.

The presence of construction vessels and associated noise and disturbance could cause short-term displacement of marine mammals from preferred habitats similar to the Proposed Action. Temporary marine mammal displacement from offshore wind energy construction sites have been observed, apparently due to vessel-related disturbance (Long 2017). Habitat use within the affected areas returned to normal after construction was completed, indicating that construction-related displacement effects would be short term in duration. On this basis, vessel displacement effects on marine mammals could range in significance from **minor** to **moderate** adverse depending on the species affected and the biological significance of displacement, recognizing that some portion of these effects is also likely the result of construction noise, as described above.

3.15.2.5.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Presence of structures: The presence of WTG and OSS monopile foundations associated with Alternative G would result in similar impacts to marine mammals as those described for the Proposed Action in Section 3.15.2.2.2, but those impacts would be reduced in extent due to the reduced number of structures.

Impacts from the presence of structures are expected to vary in relation to the total number of foundations proposed (i.e., fewer structures would result in less extensive impacts). Therefore, Alternative G would be expected to produce noticeably reduced impacts from this IPF by comparison. In general, presence of structures effects on marine mammals under this alternative is likely be less extensive compared to those resulting from the Proposed Action. Reef effects would be reduced commensurate with the number of foundations constructed. As stated in Section 3.15.2.3.2, hydrodynamic effects are likely to lead to localized changes in the distribution of phytoplankton and forage fish prey for some marine mammal species, but these changes are unlikely to be biologically significant. Therefore, while Alternative G would likely alter and reduce the extent of measurable hydrodynamic effects, those effects are likely to remain biologically insignificant. Following decommissioning and removal of the structures from the water column, the habitat would be expected to recover to conditions comparable to the environmental baseline for the surrounding habitats.

It is not currently known if the presence of structures would result in displacement effects; therefore, it is not possible to determine if reducing the number of structures and altering their configuration would reduce displacement effects. Therefore, while Alternative G would reduce the extent of reef and hydrodynamic effects, the overall impacts to marine mammals would be similar in magnitude and general scale to those resulting from the Proposed Action. On this basis, impacts from the presence of structures on marine mammals for Alternative G are expected to range from **negligible** adverse to **minor** beneficial for the life of the Project. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including species-specific displacement effects, the nature and extent of effects to forage resources, and the status of the affected population and sensitivity to effects to individuals.

3.15.2.5.3 Cumulative Impacts

This section discloses potential impacts to marine mammals associated with future offshore wind development, including Alternative G. The cumulative impact analysis for Alternative G includes the proposed configurations of Alternative G, other planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects. Cumulative impacts to marine mammals under Alternative G presented herein would be incremental to and would compound the impacts of baseline conditions on each marine mammal population considered in this EIS (see Table 3.15-2).

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: BOEM estimates a cumulative total of 104,781 acres of cabling seafloor disturbance and 10,525 acres of anchoring disturbance for Alternative G, plus all other future offshore wind projects in the GAA. Cumulative impacts would be localized, temporary, **negligible** adverse to marine mammals through anchoring and cabling-related seafloor disturbance and associated increased suspended sedimentation within the GAA. No population-level effects on marine mammals are expected from reduced water quality. However, there could be temporary displacement of marine mammals from preferred habitats, especially during construction activities, due to increased vessel activity. Vessel anchoring and cable emplacement during construction and installation, O&M, and decommissioning are not anticipated to involve equipment, lines, or rigging that could pose a potential entanglement risk to marine mammals. Therefore, Alternative G combined with past, present, and reasonably foreseeable activities would result in **negligible** to **minor** adverse cumulative effects on marine mammals.

Climate change: Cumulative impacts to marine mammals from climate change under Alternative G are expected to be of similar magnitude to those described for the Proposed Action. The nature and potential significance of climate change cumulative impacts to marine mammals from Alternative G are unknown but are likely to range from **minor** to **moderate** adverse. Impacts to specific marine mammal species, such as NARW, would be influenced by the same factors described for the Proposed Action.

Noise: Alternative G would generate underwater noise effects during Project construction, throughout the operational life of the Project, and during Project decommissioning. Those impacts would be similar in magnitude and distribution but reduced in extent relative to the Proposed Action. These effects would combine with similar effects resulting from the construction, O&M, and decommissioning of other planned offshore wind projects on the Mid-Atlantic OCS.

All future actions would be subject to the same independent NEPA analysis and regulatory approvals as Alternative G. BOEM would require all projects to incorporate the same types of EPMs included in Alternative G to avoid and minimize harmful noise effects. While these measures would avoid and minimize impacts to marine mammals to the greatest extent practicable, some unavoidable impacts on individuals are likely to occur. The impacts of each project would result in **minor** to **moderate** adverse effects on marine mammals. Effects to specific marine mammal species would depend on the number of individuals exposed to injury and behavioral level effects, the significance of those effects to survival and reproductive fitness, and the status and sensitivity of the affected population to impacts to individuals. BOEM anticipates that future MMPA approvals would consider the known status of marine mammal stocks and populations, indirectly incorporating the potential combined effects of future projects. Therefore, BOEM concludes that the cumulative effects of construction noise on marine mammals would be **moderate** adverse because of the potential for PTS, TTS, and behavioral impacts during construction activities. NARW could be an exception to this determination because of its perilous population status. Hearing-related injury to even one individual that results in reduced reproductive fitness could contribute to ongoing downward trends in population viability. However, the application of EPMs is expected to minimize the risk of hearing-related injury.

Operational noise impacts would be similar in magnitude and distribution but reduced in extent relative to the Proposed Action. These structures would contribute to and potentially increase ambient noise within each WEA, albeit at levels generally not associated with adverse effects on marine mammals. While the potential for broader effects is unclear, BOEM concludes that the cumulative effects of low-level operational noise could raise to the level of **minor** adverse for certain marine mammal species.

Cumulative impacts to marine mammals from construction of Alternative G are expected to be of similar magnitude to those described for the Proposed Action. Alternative G is likely to result in short-term displacement effects on marine mammals from the areas affected by disturbance from vessel activity, foundation installation, HRG surveys, and related activities. Several projects are expected to be constructed concurrently, potentially resulting in individual marine mammals being exposed to multiple episodes of habitat displacement. BOEM anticipates that the construction schedules for future wind projects would employ the same types of timing restrictions to protect NARW as those included in the Proposed Action, with modifications as needed to adapt to ongoing shifts in the seasonal distribution of this species (e.g., Davis et al. 2017, 2020). However, timing restrictions for NARW would not be protective for all marine mammal species. It is anticipated that future wind projects would also employ a similar range of EPMs to avoid and minimize impacts to marine mammals, but some level of short-term displacement is likely to occur, and some individual animals are likely to be exposed to multiple episodes of displacement. The significance of these potential impacts is unclear, but when all protective measures are considered, cumulative effects are likely to range from **negligible** to **moderate** adverse, varying by species. Impacts to specific species, such as NARW, are uncertain and would depend on several factors, including the nature of cumulative climate change impacts to the availability and distribution of suitable habitat and forage resources, the ability of that species to adapt to these changes, and the status and resilience of the affected population.

Presence of structures: BOEM anticipates that future wind projects within the RI/MA WEA would be constructed using 1 × 1–nm grid spacing, as does the Proposed Action. Foundations spaced at 1 × 1 nm are unlikely to pose a barrier to movement for even the largest marine mammal species. However, the broad-scale development of offshore energy structures would introduce an extended network of biologically productive artificial reefs, most generating low levels of non-impulsive sound that are detectable to marine mammals within a few hundred feet. While the individual effects of each turbine would be **minor** adverse, the broader implications of these habitat changes for marine mammals are unclear. Displacement effects that result in increased interactions between vulnerable populations of marine mammals and commercial shipping and/or fishing activity could have noticeable long-term cumulative effects. Given these uncertainties, the potential for displacement effects is unknown, but there is currently no basis to conclude that these impacts would result in greater than **minor** adverse long-term effects on any species.

The abundance of fish and invertebrate prey resources created by the artificial reef effect are likely to attract predatory marine mammals, particularly seals (e.g., Russel et al. 2014) and potentially dolphins and porpoises. Increased fish biomass around the structures could attract commercial and recreational fishing activity, leading to increased interactions between humans and marine mammals. BOEM anticipates that future offshore wind projects would perform regular inspections to identify and remove derelict fishing gear and other marine debris from offshore structures, reducing associated risks to marine mammals.

The new wind energy structures would also cause hydrodynamic effects. The GAA is characterized by strong seasonal stratification, conditions that tend to limit the hydrodynamic influence of individual foundation structures (van Berkel et al. 2020). As discussed in the previous section, the Proposed Action is not anticipated to result in additive hydrodynamic effects. However, broader scale development of contiguous projects could have more extensive effects. For example, Afsharian et al. (2020) modeled the potential effects from installation of over 400 offshore wind turbines in Lake Erie and determined that their cumulative effect on wind energy could disrupt circulation patterns and affect seasonal stratification and water temperatures over broad scales. However, these findings may not be applicable to the open ocean, where circulation patterns are strongly influenced by tides and ocean currents.

At present, currently available information suggests that hydrodynamic effects of foundation structures are likely to be localized and not additive when spaced at 1 × 1 nm in environments with strong seasonal stratification (van Berkel et al. 2020). Recent modeling of hydrodynamic effects suggests that surface currents could be affected by the presence of multiple wind farms, potentially impacting the distribution of larvae (Johnson et al. 2021). There is insufficient information to determine if this conclusion is valid for broader scale development at the levels planned within the GAA. Therefore, at this time, there is no basis to conclude that the cumulative hydrodynamic impacts of the Proposed Action in combination with planned future actions would have a measurable effect on marine mammals and their prey and forage species.

In summary, the cumulative effects of long-term habitat alteration and hydrodynamic impacts on marine mammals are unclear, could be beneficial or adverse, could range from **negligible** to **moderate** adverse, and are likely to vary depending on several factors. These factors include the nature and extent of effects on habitat suitability and forage availability, the significance of these effects to the survival and reproductive fitness, and the status and sensitivity of affected populations to effects on individuals. Although the type and magnitude of effect from displacement and shifts in prey resources due to the presence of structures are largely unknown, the possibility of changes in distribution relative to commercial fishing activity and increased interaction with fishing gear poses the potential for increased risk of entanglement. Should such changes occur, increased risk of entanglement would constitute a **minor** to **moderate** adverse effect on marine mammals, because this stressor is a documented source of injury and mortality. Effects to each marine mammal species would depend on the number of individual animals exposed to entanglement effects, the nature of the impact (i.e., injury or mortality), and the status and sensitivity of the affected population to impacts to individuals. In the case of NARW, given that entanglement has been identified as a limiting factor in the species' recovery, the potential for increased exposure to entanglement could pose a significant risk; however, specific EPMs have been developed to minimize risk for NARW. The risk of entanglement is therefore not considered to result in a greater than moderate adverse effect for NARW. It is important to stress that the likelihood of this level of effect is unclear because it is not known if the presence of structures would displace NARW and whether displacement would lead to increased fishing gear exposure. These potential long-term impacts would persist until decommissioning is complete and structures are removed. EPMs would help to offset the potential impact of entanglement within derelict fishing gear or marine debris.

Vessel traffic: BOEM estimates that, cumulatively, up to 262 construction vessels could be active within the GAA between 2022 and 2030. As discussed above for Project construction, the majority of vessel operations would be expected to occur at speeds of less than 10 knots. In addition, BOEM anticipates that future projects would adhere to mandatory and voluntary vessel speed restrictions in posted DMAs and SMAs and would implement EPMs similar to those described for the Proposed Action (see Appendix F, Table F-1) to avoid marine mammal collisions BOEM has concluded that these measures would effectively avoid all but minor adverse impacts on sensitive species such as NARW and minimize risk of vessel collisions to other marine mammal species. Therefore, the cumulative effects of increased vessel traffic on marine mammals would range from **negligible** to **moderate** adverse.

3.15.2.5.4 Conclusions

Impacts of Alternative G, the Preferred Alternative. As discussed above, the anticipated impacts from Alternative G reduce the number of WTGs and their associated IACs by approximately 35%, which would result in an incremental reduction in effects on marine mammals from certain construction and installation, O&M, and conceptual decommissioning impacts. However, BOEM anticipates that any incremental reduction in impacts would not change the resulting effects on marine mammals to the extent necessary to alter the impact-level conclusions for any impact mechanism. The incremental impact of Alternative G, when compared to the No Action Alternative, would be similar to the Proposed Action: **minor** to **moderate** adverse for mysticetes, with moderate adverse impacts to humpback whale due to permanent hearing injury to individuals and to NARW due to potential exposure of several individuals to temporary behavioral disturbance in potentially important seasonal foraging habitats, respectively. Impacts to odontocetes would range from **minor** to **moderate**, with moderate impacts to harbor porpoise from permanent hearing injury to individuals. Pinnipeds would experience **minor** to **moderate** impacts to individuals from behavioral exposure and hearing injury to individuals. Because the implementation of EPMs would avoid mortality and non-auditory injury would not occur as a result of UXO detonation, only a few marine mammals of select species are anticipated to incur PTS incidental to pile driving and UXO detonation, vessel strike risk is very low and not anticipated, and accidental spills are also not anticipated.

The impacts resulting from Alternative G, when including the baseline status of marine mammals into the impact findings and considering all phases of the Project, would be similar to those of the Proposed Action and would be **moderate** for mysticetes except for the NARW, which would be **major**. BOEM anticipates that the impacts resulting from Alternative G would be **minor to moderate** for odontocetes and pinnipeds and could include **minor beneficial** impacts. Adverse impacts are expected to result mainly from underwater noise (e.g., UXO detonations and impact pile driving) and increased vessel traffic potentially leading to vessel strikes. Beneficial impacts for odontocetes and pinnipeds are expected to result from the presence of structures.

<u>Cumulative Impacts of Alternative G, the Preferred Alternative</u>. The incremental impacts contributed by Alternative G to the cumulative impacts on marine mammals would be similar to the Proposed Action and would range from undetectable to noticeable. BOEM anticipates that the cumulative impacts of Alternative G when combined with ongoing and planned activities, including offshore wind, would be the same as the Proposed Action: **major** for NARW and **minor** to **moderate** for all other marine mammals. Some **minor beneficial** impacts to certain odontocetes and pinnipeds could be realized through artificial reef effects.

3.15.2.6 Summary of Impact Determinations to Marine Mammals for Use by NMFS in Review of the MMPA Incidental Take Regulation Application Pursuant to NEPA

This section, which includes Table 3.15-16, has been added to the Final EIS to assist the NMFS Office of Protected Resources to satisfy incremental impact analysis requirements under NEPA in support of their evaluation of Revolution Wind's application under MMPA (16 USC 1371(a)(5)(A)) for an ITR and associated Letter of Authorization and the decision of whether to issue the authorization. The incremental impact determinations presented in Table 3.15-16 summarize the incremental effect of each of the alternatives in Section 3.15.2 in the absence of baseline conditions and cumulative impacts from other planned and permitted offshore wind activities in the GAA.

Under the No Action Alternative, BOEM would not approve the RWF COP. Given this, stressors from construction, O&M, and conceptual decommissioning of the Project would not occur. Baseline conditions of the existing environment would remain unchanged. Therefore, not approving the COP would have no additional incremental effect on marine mammals. The No Action Alternative (i.e., not issuing the requested incidental take authorization under the MMPA) would also have no additional incremental impact on marine mammals and their habitat.

The determinations presented in Table 3.15-16 represent the combined incremental impacts of all IPFs from the associated alternative on the identified marine mammal species or species group. Where appropriate, incremental impacts are presented as a range where the anticipated effects of the alternative would differ between the species within that species group.

Table 3.15-16. Summary of Incremental Impact Determinations to Marine Mammals across IPFs for Use by NMFS in Review of the MMPA ITR Application Pursuant to NEPA

Species	No Action Alternative	Alternative B (Proposed Action)	Alternative C (Habitat Alternative)	Alternative D (Transit Alternative)	Alternative E (Viewshed Alternative)	Alternative F (Higher Capacity Turbine Alternative)	Alternative G (Preferred Alternative)
NARW	No effect	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Other mysticetes	No effect	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate
Odontocetes	No effect	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate
Pinnipeds	No effect	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate	Minor to moderate

Note: The incremental impacts of the action alternatives vary between the species within each species group and are therefore presented as a range.

3.15.2.7 Mitigation

Mitigation measures resulting from agency consultations for marine mammals are identified in Appendix F, Table F-2, and addressed in Table 3.15-17. Additional mitigation measures identified by BOEM and cooperating agencies are listed in Appendix F, Table F-3, and summarized in Table 3.15-18.

Table 3.15-17. Mitigation and Monitoring Measures Resulting from Consultations for Marine Mammals (Appendix F, Table F-2)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Incorporate letter of authorization (LOA) requirements	The measures required by the final MMPA LOA for Incidental Take Regulations (ITRs) would be incorporated into COP approval, and BOEM and/or BSEE would monitor compliance with these measures.	Compliance with LOA requirements would reduce risks for marine mammals under the Proposed Action from pile driving, UXO detonation, HRG surveys, and vessel operations, and provide reporting and enforcement mechanisms to ensure all monitoring and mitigation requirements are implemented. However, this measure would not alter impact determinations for marine mammals because compliance with LOA requirements is an identified EPM that is considered in the analysis of the Proposed Action.
DRAFT NMFS BiOp Reasonable and Prudent Measures (RPMs) and Terms and Conditions (T&Cs)	Draft NMFS Biological Opinion Proposed Reasonable and Prudent Measures were issued to BOEM for consideration on June 16, 2023. Final NMFS Biological Opinion Proposed Reasonable and Prudent Measures to be issued to BOEM for consideration on July 21, 2023. RPMs and Terms and Conditions to minimize the impact of incidental take of ESA-listed species were documented in the draft NMFS Biological Opinion dated June 16, 2023. These measures include adherence to mitigation measures specified in the final MMPA ITA to minimize impacts during pile driving and UXO detonation; compliance with requirements for vessel operations within the Delaware River and Delaware Bay included in the Incidental Take Statements provided with the Paulsboro Marine Terminal Biological Opinion (dated July 19, 2022); reporting requirements related to effects to, or interactions with, ESA-listed species; submittal of required plans (e.g., PSO Training Plan for Trawl Surveys, Passive Acoustic Monitoring Plan, Marine Mammal and Sea Turtle Monitoring Plan, Cofferdam Installation and Removal Monitoring Plan, Alternative Monitoring Plan/Night Time Pile Driving Monitoring Plan, Sound Field Verification Plan, Vessel Strike Avoidance Plan) to NMFS GARFO with sufficient time for review, comment and approval; and conducting on-site observation and inspection to gather information on the	These RPMs and Terms and Conditions would minimize the exposure of ESA-listed marine mammals to underwater noise impacts from impact and vibratory pile driving, UXO detonation, and HRG surveys. These RPMs and Terms and Conditions would also ensure that all incidental take that occurs is documented and reported to NMFS in a timely manner. Reporting requirements to document take would improve accountability for documenting take associated with the Proposed Action. In some cases, these PRMs and Terms and Conditions provide additional detail or clarification of measures that are included as part of the Proposed Action. Implementation of these RPMs and Terms and Conditions would provide incremental reductions in impacts on marine mammals but would not alter the overall impact determination of the Proposed Action.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	effectiveness and implementation of measures to minimize and monitor incidental take.	
NMFS EFH Conservation Recommendations	NMFS EFH Conservation Recommendations were issued to BOEM for consideration on June 16, 2023 (NMFS 2023). EFH Conservation Recommendations for activities under BOEM's jurisdiction were provided identifying proposed removal and relocation (micrositing) of selected WTG foundations and cable segments removal and relocation; construction timing restrictions to avoid potential adverse impacts to Atlantic cod; habitat alteration minimization; noise mitigation; and minimization of impacts during construction, O&M, and decommissioning. EFH Conservation Recommendations for activities under USACE's jurisdiction were provided for in-water work; offshore impact minimization; impact to scientific surveys minimization; and identification and facilitated access to mapping of relocated boulders, berms, scour, and cable protection.	Implementation of Conservation Recommendations, for timing restrictions on all construction activity in the Lease Area from November 1 to April 30, and noise mitigation during construction, such as soft starts, use of noise-dampening equipment, and noise mitigation protocols in consultation with resource agencies prior to construction activities, would avoid and minimize potential underwater noise, vessel traffic, and seabed disturbance impacts on marine mammals during the restricted period. Implementation of Conservation Recommendations to develop monitoring plans for operational noise and vibration effects would benefit marine mammals by ensuring robust experimental design, methods, and data collection/analysis to assess changes in baseline underwater noise conditions. Although implementation of the Conservation Recommendations would provide incremental reductions noise and vessel-related disturbance reductions in the overall impact rating are not anticipated for any of the Proposed Action's IPFs.
Marine debris awareness training	The Lessee would ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities must continue to develop and use a marine trash and debris awareness training and certification	Marine debris and trash awareness training would minimize the risk of marine mammal ingestion of or entanglement in marine debris. While adoption of this measure would decrease risk to marine mammals under the Proposed Action, it would not alter the impact determination for accidental releases.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	process that reasonably assures that their employees and contractors are in fact trained. The training process must include the following elements: • Viewing of either a video or slide show by the personnel specified above; • An explanation from management personnel that emphasizes their commitment to the requirements; • Attendance measures (initial and annual); and • Record keeping and the availability of records for inspection by DOI. By January 31 of each year, the Lessee would submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE via TIMSWeb with a notification email (at marinedebris@bsee.gov).	
Marine debris elimination	Materials, equipment, tools, containers, and other items used in OCS activities which could be lost or discarded overboard are of such shape or properly secured to prevent loss overboard must be clearly marked with the vessel or facility identification. All markings must clearly identify the owner and must be durable enough to resist the effects of the environmental conditions to which they may be exposed.	This measure would complement existing EPMs and regulatory requirements by providing a mechanism for enforcing accountability with EPMs and mitigation requirements, ensuring that impacts from the accidental releases and discharges IPF would remain negligible adverse.
Passive acoustic monitoring (PAM) plan	BOEM, BSEE, and USACE would ensure that Revolution Wind prepares a PAM plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the required use of PAM for monitoring. This plan must be submitted to NMFS, BOEM, and BSEE (at OSWsubmittals@bsee.gov) for review and concurrence preferably 180 days but no later than 120 days to the planned start of pile driving. Reporting to BSEE must follow JOINT NTL 2023-N01, Appendix B (BSEE and BOEM 2023).	Revolution Wind has committed to implementing passive acoustic monitoring, pile driving monitoring, PSO coverage, sound field verification, and shutdown zones as part of the Proposed Action. Compliance with these EPMs would be enforced by BOEM, BSEE, and NMFS as indicated in Table F-2. Implementation and enforcement of these EPMs would minimize the potential for Level A or Level B exposures to marine mammals during of impact pile driving, vibratory pile driving, HRG surveys, and UXO

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
		detonation, as disclosed in the analysis of the Proposed Action. This agency-proposed mitigation measure specifies plan review and reporting requirements necessary to ensure PAM plan effectiveness and enforcement. While adoption of these measures would increase accountability and ensure the effectiveness of EPMs, it would not alter the impact determination for any marine mammal hearing group or individual species as analyzed herein.
Passive acoustic monitoring, long-term	Use PAM buoys or autonomous PAM devices to record ambient noise, marine mammals, and cod vocalizations in the Lease Area before, during, and immediately after construction for up to 25 years of operation to monitor Project noise. The archival recorders must have a minimum capability of detecting and storing acoustic data on anthropogenic noise sources (such as vessel noise, pile driving, WTG operation, and whale detections), marine mammals, and cod vocalizations in the Lease Area. Monitoring would also occur during the decommissioning phase. The total number of PAM stations and array configuration will depend on the size of the zone to be monitored, the amount of noise expected in the area, and the characteristics of the signals being monitored to accomplish both monitoring during constructions, and also meet post-construction monitoring needs. Results must be provided within 90 days of construction completion and again within 90 days of the 1-year, 2-year, and 3-year anniversary of collection. The underwater acoustic monitoring must follow standardized measurement and processing methods and visualization metrics developed by the Atlantic Deepwater Ecosystem Observatory Network (ADEON) for the U.S. Mid- and South Atlantic OCS (see https://adeon.unh.edu/). At least two buoys must be independently deployed within or bordering the Lease Area or one or more buoys must be deployed in coordination with other acoustic monitoring efforts in the RI/MA and MA WEAs. As an alternative to conducting PAM in its project area, the lessee may opt to meet this monitoring requirement through an annual	Long-term PAM would provide data useful for documenting marine mammal presence in the Lease Area and vicinity and evaluating changes in population density and habitat use over the life of the project. This measure would not modify impact determinations on marine mammals but would provide the information necessary to ensure that these effects do not exceed the levels analyzed herein, and to inform existing uncertainty about potential effects on marine mammal species.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	deposit to BOEM's Environmental Studies Program in support of its Partnership for an Offshore Wind Energy Regional Observation Network (POWERON) initiative. The lessee's contribution would cover activities within its lease area, such as the purchase of instruments, annual deployments and refurbishment, data processing, and long-term data archiving. Funding from BOEM, other partners, and potentially other lessees will support long-term PAM throughout the region which will enable broader-scale analyses on cumulative effects to marine species. Under this option, the lessee will be expected to cooperate with the POWERON team to facilitate deployment and retrieval of instruments within the project area. If necessary, the lessee may request temporary withholding of the public release of acoustic data that has been collected within its project area.	
Sound field verification (SFV)	NMFS, BOEM, BSEE, and USACE would ensure that if the clearance and/or shutdown zones are expanded, PSO coverage is sufficient to reliably monitor the expanded clearance and/or shutdown zones. Additional observers must be deployed on additional platforms for every 1,500 m that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification. To validate the estimated sound field, SFV measurements would be conducted during pile driving of the first three monopiles installed over the course of the Project, with noise attenuation activated. A SFV plan would be submitted to NMFS, BOEM, USACE, and BSEE for review and approval preferably 180 days but no later than 120 days prior to planned start of pile driving. This plan would describe how Revolution Wind would ensure that the first three monopile installation sites selected for sound field are representative of the rest of the monopile installation sites and, in the case that they are not, how additional sites would be selected for SFV. This plan would also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS. The plan would describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. In the event that Revolution Wind obtains technical information that indicates a subsequent monopile is	Revolution Wind has committed to implementing passive acoustic monitoring, pile driving monitoring, PSO coverage, sound field verification, and shutdown zones as part of the Proposed Action. Compliance with these EPMs would be enforced by BOEM, BSEE, and NMFS as indicated in Table F-2. Implementation and enforcement of these EPMs would minimize the potential for Level A or Level B exposures to marine mammals during of impact pile driving, vibratory pile driving, HRG surveys, and UXO detonation, as disclosed in the analysis of the Proposed Action. This agency-proposed mitigation measure specifies plan review and reporting requirements necessary to ensure SFV plan effectiveness and enforcement. While adoption of these measures would increase accountability and ensure the effectiveness of EPMs, it would not alter the impact determination for any marine mammal hearing group or individual species as analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	likely to produce larger sound fields, SFV would be conducted for those subsequent monopiles.	
Shutdown zone and pre-start clearance zone adjustment	BOEM and BSEE, with the approval of NMFS, may consider adjustments in the pre-start clearance and/or shutdown zones based on the initial sound field verification measurements. If initial measurements indicate distances to the isopleths are greater than predicted by modeling, Revolution Wind must implement additional sound attenuation measures prior to conducting additional pile driving.	This measure would not modify the impact determination for noise effects on marine mammals (minor to moderate adverse) but would help to ensure that these effects do not exceed the levels analyzed herein.
Pile driving monitoring plan	BOEM, BSEE, and USACE would ensure that Revolution Wind prepares and submits to BSEE (via TIMSWeb and notification email at protectedspecies@bsee.gov) and BOEM (at renewable_reporting@boem.gov) for review and concurrence preferably 180 days but no later than 120 days before start of pile driving. Reporting to BSEE would follow JOINT NTL 2023-N01, Appendix B. The Lessee must not conduct pile driving operations at any time when lighting or weather conditions (e.g., darkness, rain, fog, sea state) prevent visual monitoring of the full extent of the clearance and shutdown zones including not initiating pile driving earlier than 1 hour after civil sunrise or later than 1.5 hours prior to civil sunset. Pile driving at night may only occur with prior approval of an Alternative Monitoring Plan (AMP). The Lessee must submit an AMP to BOEM and NMFS for review and approval at least 6 months prior to the planned start of pile-driving. This plan may include deploying additional observers, alternative monitoring technologies such as night vision, thermal, and infrared technologies, or use of PAM and must demonstrate the ability and effectiveness to maintain all clearance and shutdown zones during daytime as outlined below in Part 1 and nighttime as outlined in Part 2 to BOEM's and NMFS's satisfaction. The AMP must include two stand-alone components as described below:	Revolution Wind has committed to implementing passive acoustic monitoring, pile driving monitoring, PSO coverage, sound field verification, and shutdown zones as part of the Proposed Action. Compliance with these EPMs would be enforced by BOEM, BSEE, and NMFS as indicated in Table F-2. Implementation and enforcement of these EPMs would minimize the potential for Level A or Level B exposures to marine mammals during of impact pile driving, vibratory pile driving, HRG surveys, and UXO detonation, as disclosed in the analysis of the Proposed Action. This agency-proposed mitigation measure specifies plan review and reporting requirements necessary to ensure pile driving monitoring plan effectiveness and enforcement. While adoption of these measures would increase accountability and ensure the effectiveness of EPMs, it would not alter the impact determination for any marine mammal hearing group or individual species as analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	Part 1 – Daytime when lighting or weather (e.g., fog, rain, sea state) conditions prevent visual monitoring of the full extent of the clearance and shutdown zones. Daytime being defined as one hour after civil sunrise to 1.5 hours before civil sunset. Part 2 – Nighttime inclusive of weather conditions (e.g., fog, rain, sea state). Nighttime being defined as 1.5 hours before civil sunset to one hour after civil sunrise. If a protected marine mammal or sea turtle is observed entering or found within the shutdown zones after impact pile-driving has commenced, the Lessee would follow shutdown procedures outlined in the Protected Species Mitigation Monitoring Plan (PSMMP; Appendix B). The Lessee would notify BOEM and NMFS of any shutdown occurrence during piling driving operations within 24 hours of the occurrence unless otherwise authorized by BOEM and NMFS. The AMP should include, but is not limited to the following information: • Identification of night vision devices (e.g., mounted thermal/IR camera systems, hand-held or wearable NVDs, IR spotlights), if proposed for use to detect protected marine mammal and sea turtle species. • The AMP must demonstrate (through empirical evidence) the capability of the proposed monitoring methodology to detect marine mammals and sea turtles within the full extent of the established clearance and shutdown zones (i.e., species can be detected at the same distances and with similar confidence) with the same effectiveness as daytime visual monitoring (i.e., same detection probability). Only devices and methods demonstrated as being capable of detecting marine mammals and sea turtles to the maximum extent of the clearance and shutdown zones will be acceptable. • Evidence and discussion of the efficacy (range and accuracy) of each device proposed for low visibility	

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	monitoring must include an assessment of the results of field studies (e.g., Thayer Mahan demonstration), as well as supporting documentation regarding the efficacy of all proposed alternative monitoring methods (e.g., best scientific data available). • Procedures and timeframes for notifying NMFS and BOEM of Revolution Wind's intent to pursue nighttime pile-driving. • Reporting procedures, contacts and timeframes. BOEM may request additional information, when appropriate, to assess the efficacy of the AMP. For mammals see Appendix B MMPA rule.	
PSO coverage	BOEM, BSEE, and USACE would ensure that PSO coverage is sufficient to reliably detect marine mammals and sea turtles at the surface in clearance and shutdown zones to execute any pile driving delays or shutdown requirements. If, at any point prior to or during construction, the PSO coverage that is included as part of the proposed action is determined not to be sufficient to reliably detect ESA-listed whales and sea turtles within the clearance and shutdown zones, additional PSOs and/or platforms must be deployed. Determinations prior to construction would be based on review of the Pile Driving Monitoring Plan. Determinations during construction must be based on review of the weekly pile driving reports and other information, as appropriate.	Revolution Wind has committed to implementing passive acoustic monitoring, pile driving monitoring, PSO coverage, sound field verification, and shutdown zones as part of the Proposed Action. Compliance with these EPMs would be enforced by BOEM, BSEE, and NMFS as indicated in Table F-2. Implementation and enforcement of these EPMs would minimize the potential for Level A or Level B exposures to marine mammals during of impact pile driving, vibratory pile driving, HRG surveys, and UXO detonation, as disclosed in the analysis of the Proposed Action. This agency-proposed mitigation measure specifies enforcement necessary to ensure that PSO coverage is sufficient to avoid and minimize adverse impacts to marine mammals. While adoption of these measures would increase accountability and ensure the effectiveness of EPMs, it would not alter the impact determination for any marine mammal hearing group or individual species as analyzed herein.
Shutdown zones and pre-start clearance zone adjustment	BOEM, BSEE, and NMFS may consider adjustments in the pre-start clearance and/or shutdown zones based on the initial sound field verification (SFV) measurements. Revolution Wind will provide the initial results of each SFV measurement to BOEM, BSEE, and NMFS	This measure would not modify the impact determination for noise effects on marine mammals (minor to moderate adverse) but establishes adaptive management measures

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	in an interim report after each monopile installation. Interim reports must be submitted as soon as they are available but no later than 48 hours after each installation. Revolution Wind will conduct a SFV to empirically determine the distances to the isopleths corresponding to Level A harassment and Level B harassment thresholds, including at the locations corresponding to the modeled distances to the Level A harassment and Level B harassment thresholds. If initial SFV measurements indicate distances to the isopleths are less than the distances predicted by modeling assuming 10-dB attenuation, Revolution Wind may request a modification of the clearance and shutdown zones for impact pile driving. For a modification request to be considered, Revolution Wind must have conducted SFV on at least three piles to verify that zone sizes are consistently smaller than predicted by modeling. If initial SFV measurements from any foundation indicate distances to the isopleths are greater than the distances predicted by modeling, Revolution Wind will implement additional sound attenuation measures prior to conducting additional pile driving. Additional measures may include improving the efficacy of the implemented noise attenuation technology and/or modifying the piling schedule to reduce the sound source. If modeled zones cannot be achieved by these corrective actions, Revolution Wind must install an additional noise mitigation system to achieve the modelled ranges. Each sequential modification will be evaluated empirically by SFV of three additional foundations with the new sound attenuation technology. Additionally, in the event that SFV measurements continue to indicate distances to isopleths corresponding to Level A harassment and Level B harassment thresholds are consistently greater than the distances predicted by modeling, BOEM, BSEE, or NMFS may expand the relevant clearance and shutdown zones and associated monitoring measures.	and an enforcement mechanism to ensure these effects do not exceed the levels analyzed herein.
Vessel strike avoidance plan measures	BOEM must require Revolution Wind to comply with measures and reporting outlined in the final vessel strike avoidance plan per the MMPA ITR LOA, and NMFS's vessel strike avoidance and reporting	Revolution Wind has committed to implementing a vessel strike avoidance policy, vessel separation distances, and vessel speed restrictions as part of the Proposed Action

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	measures included in the final MMPA ITR and ESA biological opinion.	and as described in Table F-4. These measures include maintaining specified separation distances for NARW and unidentified large marine mammals, other large whales, and dolphins, porpoises, seals, and sea turtles. Revolution Wind's vessel strike avoidance policy directs that if an animal is sighted in the vessel's path, the vessel will divert or reduce speed and shift gears to neutral (see Table F-4). Project design criteria to minimize vessel interactions with listed species would further clarify the distance at which vessels would divert their path and the distance at which vessels would reduce speed and shift to neutral. Adoption of these measures would further clarify requirements for vessel strike avoidance under the Proposed Action but would not alter the impact determinations for any marine mammal species as analyzed herein.
Vessel strike PSO requirements	Protected Species Observer Requirements (Construction)(Operations)(Decommissioning). The Lessee must ensure that vessel operators and crew members maintain a vigilant watch for marine mammals and sea turtles, and reduce vessel speed, alter the vessel's course, or stop the vessel as necessary to avoid striking marine mammals or sea turtles. All vessels must have a visual observer on board who is responsible for monitoring the vessel strike avoidance zone for marine mammals and sea turtles. Visual observers may be PSO or crew members, but crew members responsible for these duties must be provided sufficient training by the Lessee to distinguish marine mammals from other phenomena and must be able to identify a marine mammal as a North Atlantic right whale, other whale (defined in this context as sperm whales or baleen whales other than North Atlantic right whales), or other marine mammal. Crew members serving as visual observers must not have duties other than observing for marine mammals while the vessel is operating over 10 kts;	Revolution Wind has committed to implementing passive acoustic monitoring, pile driving monitoring, PSO coverage, sound field verification, and shutdown zones as part of the Proposed Action. Compliance with these EPMs would be enforced by BOEM, BSEE, and NMFS as indicated in Table F-2. Implementation and enforcement of these EPMs would minimize the potential for Level A or Level B exposures to marine mammals during of impact pile driving, vibratory pile driving, HRG surveys, and UXO detonation, as disclosed in the analysis of the Proposed Action. This agency-proposed mitigation measure specifies PSO coverage, monitoring, and notification requirements necessary to avoid and minimize vessel strike risk to marine mammals. While adoption of these measures would increase accountability and ensure the effectiveness of EPMs, it would not alter the impact determination for any marine mammal hearing group or individual species as analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	Vessel Communication of Threatened and Endangered Species Sightings (Planning) (Construction) (Operations) (Decommissioning). The Lessee must ensure that whenever multiple Project vessels are operating, any detections of ESA-listed species (marine mammals and sea turtles) are communicated in near real time to these personnel on the other Project vessels: Protected Species Observer (PSO), vessel captains, or both. Year-round, all vessel operators must monitor, the project's Situational Awareness System, WhaleAlert, US Coast Guard VHF Channel 16, and the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales once every 4-hour shift during project-related activities. The PSO and PAM operator monitoring teams for all activities must also monitor these systems no less than every 12 hours. If a vessel operator is alerted to a North Atlantic right whale detection within the project area, they must immediately convey this information to the PSO and PAM teams. For any UXO/MEC detonation, these systems must be monitored for 24 hours prior to blasting; Any observations of any large whale by any of the Lessee's staff or contractor, including vessel crew, must be communicated immediately to PSOs and all vessel captains to increase situational awareness.	
Vessel speed requirements	Between November 1st and April 30th, all vessels, regardless of size, must operate at 10 kts or less when traveling between the lease area and ports in New York, Connecticut, Rhode Island, and Massachusetts; All vessels, regardless of size, must immediately reduce speed to 10 kts or less when any large whale, mother/calf pairs, or large assemblages of non-delphinid cetaceans are observed (within 500 m) of an underway vessel; All vessels, regardless of size, must immediately reduce speed to 10 kts or less when a North Atlantic right whale is sighted, at any distance, by anyone on the vessel;	Revolution Wind has committed to implementing passive acoustic monitoring, pile driving monitoring, PSO coverage, sound field verification, and shutdown zones as part of the Proposed Action. Compliance with these EPMs would be enforced by BOEM, BSEE, and NMFS as indicated in Table F-2. Implementation and enforcement of these EPMs would minimize the potential for Level A or Level B exposures to marine mammals during of impact pile driving, vibratory pile driving, HRG surveys, and UXO detonation, as disclosed in the analysis of the Proposed Action.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	If a vessel is traveling at greater than 10 knots, in addition to the required dedicated visual observer, the Lessee must monitor the transit corridor in real-time with PAM prior to and during transits. If a North Atlantic right whale is detected via visual observation or PAM within or approaching the transit corridor, all crew transfer vessels must travel at 10 kts or less for 12 hours following the detection. Each subsequent detection shall trigger a 12-hour reset. A slowdown in the transit corridor expires when there has been no further visual or acoustic detection in the transit corridor in the past 12 hours; All underway vessels (e.g., transiting, surveying) operating at any speed must have a dedicated visual observer on duty at all times to monitor for marine mammals within a 180° direction of the forward path of the vessel (90° port to 90° starboard) located at an appropriate vantage point for ensuring vessels are maintaining appropriate separation distances. Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, fog, etc.). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements in this subpart. Visual observers may be third-party observers (i.e., NMFS-approved PSOs) or crew members. Observer training related to these vessel strike avoidance measures must be conducted for all vessel operators and crew prior to the start of in-water construction activities. Confirmation of the observers' training and understanding of the ITA requirements must be documented on a training course log sheet and reported to NMFS; All vessels must maintain a minimum separation distance of 500 m from North Atlantic right whales. If underway, all vessels must steer a course away from any sighted North Atlantic right whale at 10 kts or less such that the 500-m minimum separation distance requirement is not violated. If a North Atlantic right whale is sighted within 500 m of an underway vessel, that vessel must shift	

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 m. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take the vessel strike avoidance measures described in this paragraph (b)(2)(xi); All vessels must maintain a minimum separation distance of 100 m from sperm whales and non-North Atlantic right whale baleen whales. If one of these species is sighted within 100 m of an underway vessel, that vessel must shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 100 m; All vessels must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all delphinoid cetaceans and pinnipeds, with an exception made for those that approach the vessel (e.g., bow-riding dolphins). If a delphinid cetacean or pinniped is sighted within 50 m of an underway vessel, that vessel must shift the engine to neutral, with an exception made for those that approach the vessel (e.g., bow-riding dolphins). Engines must not be engaged until the animal(s) has moved outside of the vessel's path and beyond 50 m; When a marine mammal(s) is sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distances (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If a marine mammal(s) is sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engine(s) until the animal(s) is clear of the area. This does not apply to any vessel towing gear or any situation where respecting the relevant separation distance would be unsafe (i.e., any situation where the vessel is navigationally constrained); All vessels underway must not divert or alter course to approach any marine mammal. Any vessel underway must avoid speed over	

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	10 kts or abrupt changes in course direction until the animal is out of an on a path away from the separation distances; and For in-water construction heavy machinery activities other than impact or vibratory pile driving, if a marine mammal is on a path towards or comes within 10 m of equipment, the Lessee must cease operations until the marine mammal has moved more than 10 m on a path away from the activity to avoid direct interaction with equipment.	
Vessel speed restriction	All vessels, regardless of size, would comply with a 10-knot speed restriction in any SMA, DMA, or Slow Zone. On August 1, 2022, NMFS published a proposed rule for changes to NARW vessel speed regulations to further reduce the likelihood of mortalities and serious injuries from vessel collisions (87 Federal Register [FR] 46921. If the proposed rule becomes final, BOEM would require appropriate restrictions per area.	This measure would complement existing EPMs and ensure their effectiveness. Although it would not modify the impact determination for vessel-related displacement effects on marine mammals (minor to moderate adverse), it would help to ensure that these effects do not exceed the levels analyzed herein.
Sampling gear	All sampling gear must be hauled out at least once every 30 days, and all gear must would be removed from the water and stored on land between survey seasons to minimize risk of entanglement.	This measure would complement existing EPMs and ensure that entanglement risk and potential impacts on marine mammals remain negligible.
Lost survey gear	If any survey gear is lost, all reasonable efforts that do not compromise human safety must be undertaken to recover the gear. All lost gear must be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (via TIMSWeb and notification email at marinedebris@bsee.govOSWIncidentReporting@bsee.gov) within 24 hours of the documented time of missing or lost gear. This report must include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	This measure would complement existing EPMs and ensure that entanglement risk and potential impacts on marine mammals remain negligible.
Training	At least one of the survey staff onboard the trawl surveys and ventless trap surveys must have completed NEFOP observer training (within the last 5 years) or other training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon). Reference materials for identification, disentanglement, safe handling, and genetic sampling procedures must be available on board each survey	This measure would complement existing EPMs and ensure that entanglement risk and potential impacts on marine mammals remain negligible.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	vessel. BOEM and BSEE would ensure that Revolution Wind prepares a training plan that addresses how this requirement would be met and that the plan is submitted to NMFS in advance of any trawl or trap surveys. This requirement is in place for any trips where gear is set or hauled.	
Monthly/ annual reporting requirements	BOEM and BSEE would ensure that Revolution Wind submits regular reports (in consultation with NMFS) necessary to document the amount or extent of take that occurs during all phases of the proposed action. Details of reporting must be coordinated between Revolution Wind, NMFS, BOEM and BSEE. All reports would be sent to: nmfs.gar.incidental- take@noaa.gov and via TIMSWeb and notification email at protectedspecies@bsee.gov.	This measure would not modify the impact determination for marine mammals, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.
Periodic underwater surveys, reporting of monofilament and other fishing gear around WTG foundations	BOEM will require Lessee to monitor potential loss of fishing gear in the vicinity of WTG foundations by surveying at least ten percent of the total installed foundations annually. Survey design and effort may be modified based upon previous survey results after review and concurrence by BOEM. The Lessee must conduct surveys by remotely operated vehicles, divers, or other means to determine the locations and amounts of marine debris. The Lessee must submit annual reports to BOEM and BSEE by no later than April of the year following the survey. Survey reports will meet all requirements specified in Appendix F, Table F-2. Required data and reports may be archived, analyzed, published, and disseminated by BOEM.	This measure would not modify the impact determination for marine mammals, but it would provide the information necessary to ensure that effects do not exceed the levels analyzed herein.
Data collection BA BMPs	BOEM and BSEE must ensure that all Project design criteria and BMPs incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (BOEM 2021c) shall be applied to activities associated with Project construction and O&M, as applicable.	This measure would not modify impact determinations on marine mammals but would provide the information necessary to ensure that these effects do not exceed the levels analyzed herein.
Reporting of all North Atlantic right whale (NARW) sightings	If a NARW is observed at any time by PSOs or personnel on any Project vessels, during any Project-related activity, or during vessel transit, Revolution Wind must report the sighting information to NMFS as soon as feasible and no later than within 24 hours after	This measure would not modify the impact determination for any IPF but would contribute to improved

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	conclusion of the detection event (the time, location, number of animals, closest point of approach of animals, animal behavior, activities at time of detection, vessel speed, and any mitigation measures implemented) via the WhaleAlert app (http://www.whalealert.org/), NMFS Right Whale Sighting Advisory System hotline (phone), and PR.ITP.MonitoringReports@noaa.gov.	understanding of marine mammal use of the RWF and vicinity.
Long-term PAM (proposed by BOEM)	Long-term monitoring of ambient noise, marine mammal, and cod vocalizations in the Lease Area before, during, and following construction. Continuous recording must occur at least 30 days prior to pile driving, during foundation pile driving, initial operation, and for at least 3 full calendar years of operation to monitor for potential impacts. At least three devices must be independently deployed within the lease area to maximize spatial coverage of the project area based on 10-kilometer spacing between deployment locations or as otherwise agreed between BOEM and the Lessee. The locations of the three buoys must be coordinated with the Regional Wildlife Science Collaborative prior to the plan being submitted to BOEM and BSEE. Devices may be moved to new locations during the recording period, if existing PAM devices will be present in the lease area providing continuous recording. The archival recorders must have a minimum capability of continuously detecting and storing acoustic data on vessel noise, pile-driving, WTG operation, baleen whale vocalizations, and cod vocalizations in the lease area. No later than 180 days prior to buoy deployment, the Lessee must submit to BOEM and BSEE (renewable_reporting@boem.gov and OSWsubmittals@bsee.gov) the PAM plan, which describes all proposed equipment, deployment locations, detection review methodology, and other procedures and protocols related to the required use of PAM for monitoring. The PAM plan must detail mooring best practices, data management, storage, measurement, and data processing best practices that are required by BOEM for long-term PAM monitoring. Refer to Regional Wildlife Science Collaborative for Offshore Wind Data Management & Storage Best Practices for	Long-term PAM would provide data useful for documenting marine mammal presence in the Lease Area and vicinity and evaluating changes in population density and habitat use over the life of the project. This measure would not modify impact determinations on marine mammals but would provide the information necessary to ensure that these effects do not exceed the levels analyzed herein, and to inform existing uncertainty about potential effects on marine mammal species.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	Long-term and Archival Passive Acoustic Monitoring (PAM) Data. Other best practices consistent with COP approval should be detailed in the plan. The long-term PAM Plan must include the proposed equipment, sample rate, mooring design, deployment locations, methods for baleen whale and cod detections, and metrics for ambient noise analysis. The long-term PAM plan must be submitted to BOEM and BSEE (at renewable_reporting@boem.gov and OSWsubmittals@bsee.gov) for review and concurrence. BOEM and BSEE will review the long-term PAM Plan and provide comments, if any, on the plan within 45 calendar days, but no later than 90 days of its submittal. The plan must satisfy all outstanding comments to BOEM's and BSEE's satisfaction. The Lessee will receive written concurrence from DOI upon acceptance of the final long-term PAM plan. If DOI does not provide comments on the long-term PAM Plan within 90 calendar days of its submittal, the Lessee may conclusively presume DOI's concurrence with the long-term PAM Plan. Long-term PAM monitoring results must be provided within 180 days of buoy collection and again within 180 days of the annual anniversaries of each the PAM device deployments. All raw data must be sent to NCEI for archiving no later than 6 months following the date of each recorder recovery. As an alternative to conducting long-term PAM in its project area, the lessee may opt to meet this monitoring requirement through an annual deposit to BOEM's Environmental Studies Program in support of its Partnership for an Offshore Wind Energy Regional Observation Network (POWERON) initiative. The lessee's contribution would cover activities within the area of potential effect of the project, such as the purchase of instruments, annual deployments and refurbishment, data processing, and long-term data archiving. Funding from BOEM, other partners, and potentially other lessees will support long-term PAM throughout the region which will enable broader-scale analyses on cumulative effects to marine species. Under this option, the Lessee will be expected to cooperate with the POWERON team to facilitate	

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	deployment and retrieval of instruments within the project area. If necessary, the Lessee may request temporary withholding of the public release of acoustic data that has been collected within its project area. Record long-term measurements of ambient noise, marine mammal, and cod vocalizations in the Lease Area before, during, and following construction.	

Table 3.15-18. Additional Mitigation and Monitoring Measures Under Consideration for Marine Mammals (Appendix F, Table F-3)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Federal survey mitigation	There are 14 NMFS scientific surveys that overlap with wind energy development in the northeast region and eight of these surveys overlap with the Project. As per NMFS and BOEM Survey Mitigation strategy actions 1.3.1, 1.3.2, 2.1.1, and 2.1.2 (Hare et al. 2022), within 120 calendar days of COP Approval, the Lessee must submit to BOEM a draft survey mitigation agreement between NMFS and the Lessee. The survey mitigation agreement will describe how the Lessee will mitigate the Project impacts on the eight NMFS surveys. If after consultation with NMFS NEFSC, BOEM deems the survey mitigation agreement acceptable, the mitigation will be considered required as a term and condition of the Project's COP approval. As soon as reasonably practicable, but no later than 30 days after the issuance of the Project's COP Approval, the Lessee will initiate coordination with NMFS NEFSC to develop the survey mitigation agreement described above. Mitigation activities specified under the agreement will be designed to mitigate the Project impacts on the following NMFS NEFSC surveys: (a) Spring Bottom Trawl survey; (b) Autumn Multi-species Bottom Trawl survey; (c) Ecosystem Monitoring survey; (d) NARW aerial survey; (e) Aerial marine mammal and sea turtle survey; (f) Shipboard marine mammal and sea turtle survey; (g) Atlantic surfclam and ocean quahog survey; and (h) Atlantic sea scallop survey. At a minimum, the survey mitigation agreement will describe actions needed and the means to address impacts on the affected surveys due	This measure provides a mechanism to avoid and minimize adverse impacts of project O&M on scientific surveys used to monitor the status of marine mammal populations and their forage and prey organisms. The implementation of this measure would ensure that federal surveys continue to provide the data and information necessary to monitor marine mammal population status. Federal survey data will be used to ensure that impacts to marine mammals remain within the levels considered in this FEIS, and to address uncertainties identified in impact analysis.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	to the preclusion of sampling platforms and impacts on statistical designs. In terms of statistical design, the project will be viewed as a discrete stratum in surveys that use a random stratified design. Other anticipated Project impacts on NMFS surveys such as changes in habitat and increased operational costs due to loss of sampling efficiencies may also be addressed in the agreement. The survey mitigation agreement will identify activities that will result in the generation of data equivalent to data generated by NMFS's affected surveys for the duration of the Project. The survey mitigation agreement will describe the implementation procedures by which the Lessee will work with NEFSC to generate, share, and manage the data required by NEFSC for each of the surveys impacted by the Project, as mutually agreed upon between the Lessee and NMFS/NEFSC. The survey mitigation agreement must also describe the Lessee's participation in the NMFS NEFSC Northeast Survey Mitigation Program to support activities that address regional-level impacts for the surveys listed above.	

3.15.2.7.1 Measures Incorporated into the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.15-16 and in Appendix F, Table F-2, are incorporated into Alternative G (Preferred Alternative). BOEM has identified additional measures in Table 3.15-17. These measures, if adopted, would further define how the effectiveness and enforcement of EPMs would be ensured and improve accountability for compliance with EPMs by requiring the submittal of plans for approval by the enforcing agency(ies) and by defining reporting requirements. Because these measures ensure the effectiveness of and compliance with EPMs that are already analyzed as part of the Proposed Action, implementation of these measures would not further reduce the impact level of the Proposed Action from what is described in Section 3.15.2.

3.16 Navigation and Vessel Traffic

3.16.1 Description of the Affected Environment for Navigation and Vessel Traffic

Geographic analysis area: The GAA for navigation and vessel traffic impacts includes the Lease Area, all other wind energy lease areas (for the cumulative effects analysis), and the bays surrounding each of the ports listed in Section 3.11 as being potentially used by the Project during construction or operations, as shown in Figure 3.16-1.

In Figure 3.16-1, "Wind Farm Ports (Listed in the COP)" are those potentially used for construction or operations activities, including WTG tower, nacelle, and blade storage; pre-commissioning and marshalling; foundation marshalling and advanced foundation component fabrication; and construction hub and/or O&M activities (see COP Table 3.3.10-1 [VHB 2023]). "Commercial Fishing Only" refers to those ports identified as commercial fishing or for-hire recreational fishing ports, as discussed in Section 3.11.

The OCS-A 0501 and OCS-A 0517 wind energy lease areas are included under Alternative A. The other wind energy lease areas considered in the cumulative analysis include the following RI/MA WEA and MA WEA Lease Areas: OCS-A 0487, OCS-A 0500, OCS-A 0520, OCS-A 0521, and OCS-A 0522. See Table E-3 in Appendix E for more information.

Affected environment: The navigational safety risk assessment (NSRA) (DNV GL Energy USA, Inc. 2020) analyzed all vessels with Automatic Identification System (AIS) data[45] using data for July 1, 2018, through June 30, 2019, supplemented with vessel monitoring system (VMS) data for calendar year 2016, density maps, the final USCG (2020) report *The Areas Offshore of Massachusetts and Rhode Island Port Access Route Study* (MARIPARS), and stakeholder input (DNV GL Energy USA, Inc. 2020). The assessment used a 5-mile radius around the Project to determine the vessel types transiting in the area during this time period and evaluation incidents; AIS data suggest that primarily only fishing and other/unidentified vessels currently transit within the Lease Area.

[45] AIS data cover those vessels that are required to carry a transponder—or that choose to carry one—according to AIS requirements at 33 CFR 164.01, 164.02, 164.46, and 164.53. Most smaller vessels are not covered in the data. AIS data underestimate the scale of commercial fishing vessel activities, as transponders are only required for vessels over 65 feet and can be turned off after 12 nm. See Section 3.9 for a discussion of VMS data used for commercial fishing vessels.

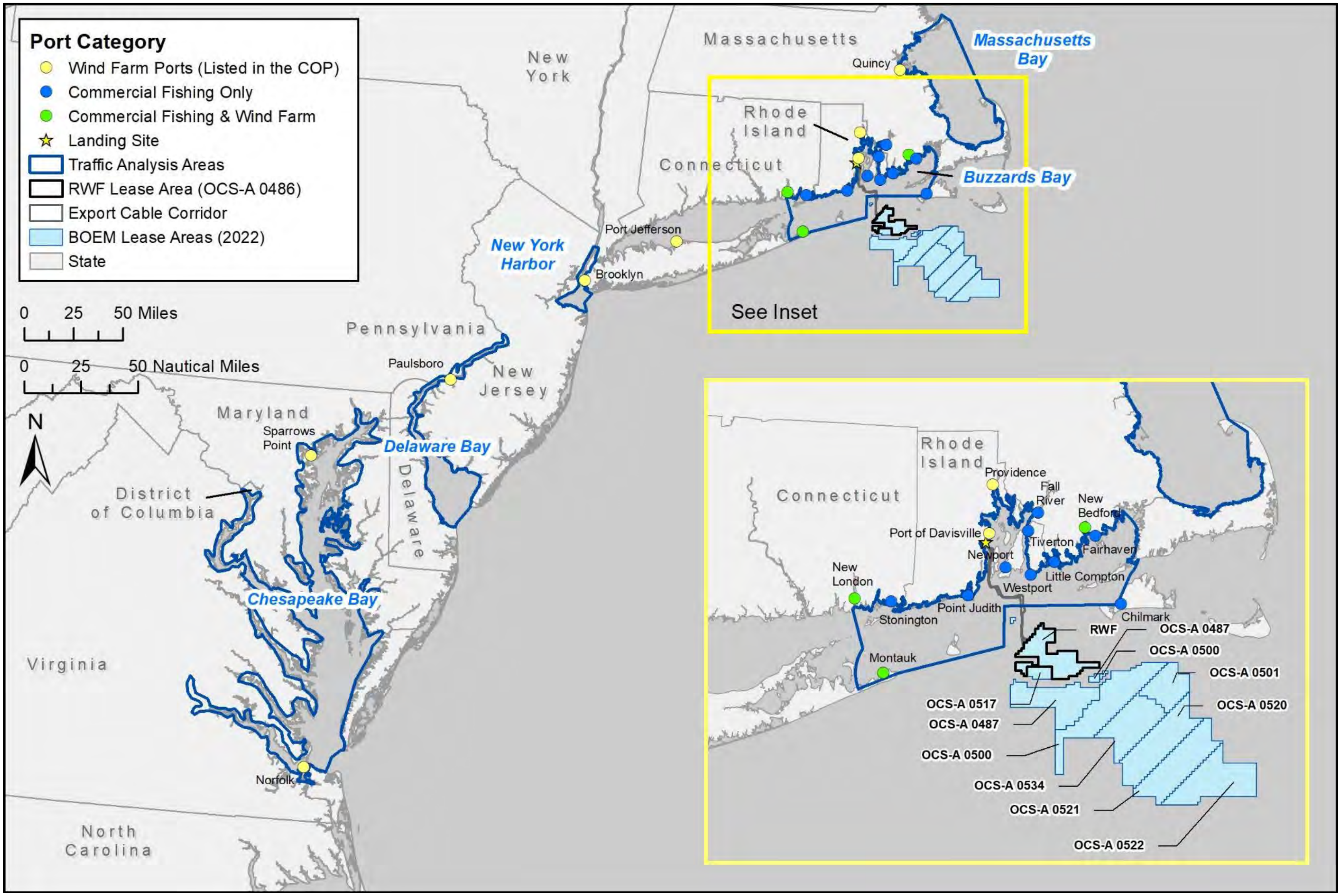

Figure 3.16-1. Geographic analysis area for navigation and vessel traffic.

MARIPARS analyzed AIS data within the leased areas of the RI/MA WEA and MA WEA (study area) shown in Figure 3.16-1[46] (USCG 2020:Figure 3). The MARIPARS study found 13,000 to 46,900 annual vessel transits through the study area. Activity during the summer months was quadruple that of January and February. The study concluded that vessel activity in the study area was largely commercial fishing. Fishing vessels primarily originated from several ports in Rhode Island, Massachusetts, or New York and transited the study area to reach fishing grounds and other areas southeast of the study area. Recreational vessels were more expected to transit within the structure arrays and less expected to use USCG designated routes. Passenger vessels largely did not transit the study area. Deep draft and towing vessels transited the study area, mostly on the west side, and tug and towing vessels had a low frequency of transit in the study area. MARIPARS did not evaluate other and unidentified vessels, although many appeared to be misclassified fishing vessels.

AIS data for 2019 (Office for Coastal Management [OCM] 2020) were further analyzed to measure the time and distance that vessels spent within the Lease Area. In 2019, vessels traveled 42,424 miles in the Lease Area. The majority of miles are attributed to fishing vessels, which accounted for 39% of all vessel miles traveled. Pleasure craft accounted for 6% of miles (Table 3.16-1). Table 3.16-2 summarizes activity in the basins in the GAA, as measured by miles traveled. Chesapeake Bay had the most activity, and pleasure craft/sailing vessels were the most common vessel there. New York Harbor was the second busiest, with passenger vessels contributing more than half of the activity. Tug tow vessels accounted for a substantial number of miles traveled in Chesapeake Bay, New York Harbor, and Delaware Bay (each with more than 500,000 miles traveled). Fishing vessels had the most activity in Buzzards Bay. Deep draft vessels accounted for very little of the activity; the largest contribution was in Chesapeake Bay, with 537,000 miles of 3,775,000 miles total.

Table 3.16-1. Distance Vessels Traveled inside Lease Area (miles)

Vessel Type	Revolution Wind Lease Area	Other Contiguous Rhode Island/Massachusetts Wind Energy Area Lease Areas*
Cargo	208	3,127
Fishing	16,336	84,599
Not available	10,700	11,789
Other	12,173	18,744
Passenger	498	2,208
Pleasure craft/Sailing	2,363	6,137
Tanker	97	4,054
Tug tow	49	529
Total	**42,424**	**131,188**

Source: OCM (2020).
* Refer to Figure 1.1-2 for location of the RI/MA and MA WEAs.

[46] MARIPARS includes the following BOEM lease areas in the RI/MA and MA WEAs: OCS-A 0486 (now subdivided as OSC-A 0517 and OCS-A 0486 [RWF]), OCS-A 0487, OCS-A 0500, OCS-A 0501, OCS-A 0520, OCS-A 0521, and OCS-A 0522. See Table E-3 in Appendix E for more information.

Table 3.16-2. Distance Vessels Traveled inside Basins (thousands of miles)

Port	Cargo	Fishing	Not Available	Other	Passenger	Pleasure Craft/Sailing	Tanker	Tug Tow	Total
Buzzards Bay	30	312	115	93	328	654	21	256	1,810
Chesapeake Bay	537	108	233	278	367	1,179	41	1,030	3,775
Delaware Bay	248	16	125	77	165	92	108	554	1,386
Maine	2	42	2	3	6	35	4	5	99
Massachusetts Bay	23	68	137	83	409	233	21	227	1,200
New York Harbor	79	4	517	117	1,991	152	40	563	3,464

Source: Developed using OCM (2020).

Figures 3.16-2 and 3.16-3 show close-up views of the Project with vessel traffic (based on AIS data). Tanker cargo vessels and tug and towing vessels generally travel in the internationally designated traffic separation schemes to the north and west of the Lease Area. These vessels can approach or exit the Narragansett Bay traffic separation scheme in a northwest–southeast orientation, leading some to transit through the Lease Area. East of and at the approximate latitude of Old Harbor, cargo vessels diverge from the north–south traffic lanes, and some transit through the Lease Area. Passenger vessels, typically ferries or cruise ships, generally avoid the Lease Area and would often follow a similar route. The Lease Area is located outside the designated lanes used by most commercial vessel traffic.

Fishing vessels operate all over the region, sometimes fishing and often transiting, with their vessel movements recorded through AIS, VMS, or not at all (see Section 3.9.1). Relative to the areas closer to the coast and traffic lanes, there is less vessel traffic near the Lease Area.

The NSRA modeled vessel incident data, showing no collisions or allisions in the Lease Area and estimating a total of 0.7543 collisions per year and no allisions in the NSRA's study area, which included the Lease Area (DNV GL Energy USA, Inc. 2020:Table E-6). The results of the model show that fishing vessels would experience the most frequent rate of incidents, accounting for nearly all of the collisions, at 0.7325 per year.

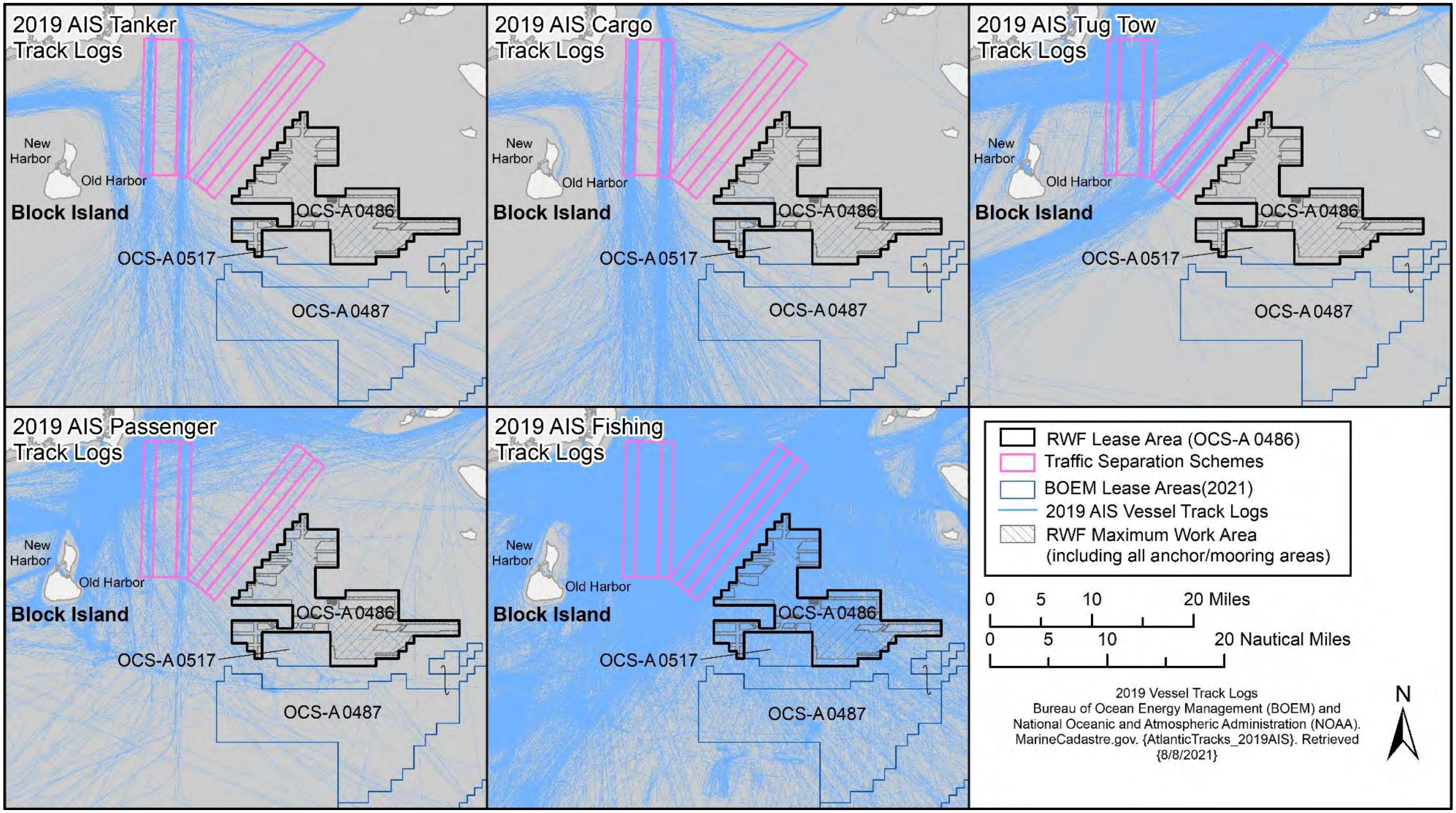

Figure 3.16-2. Vessel traffic near the Lease Area.

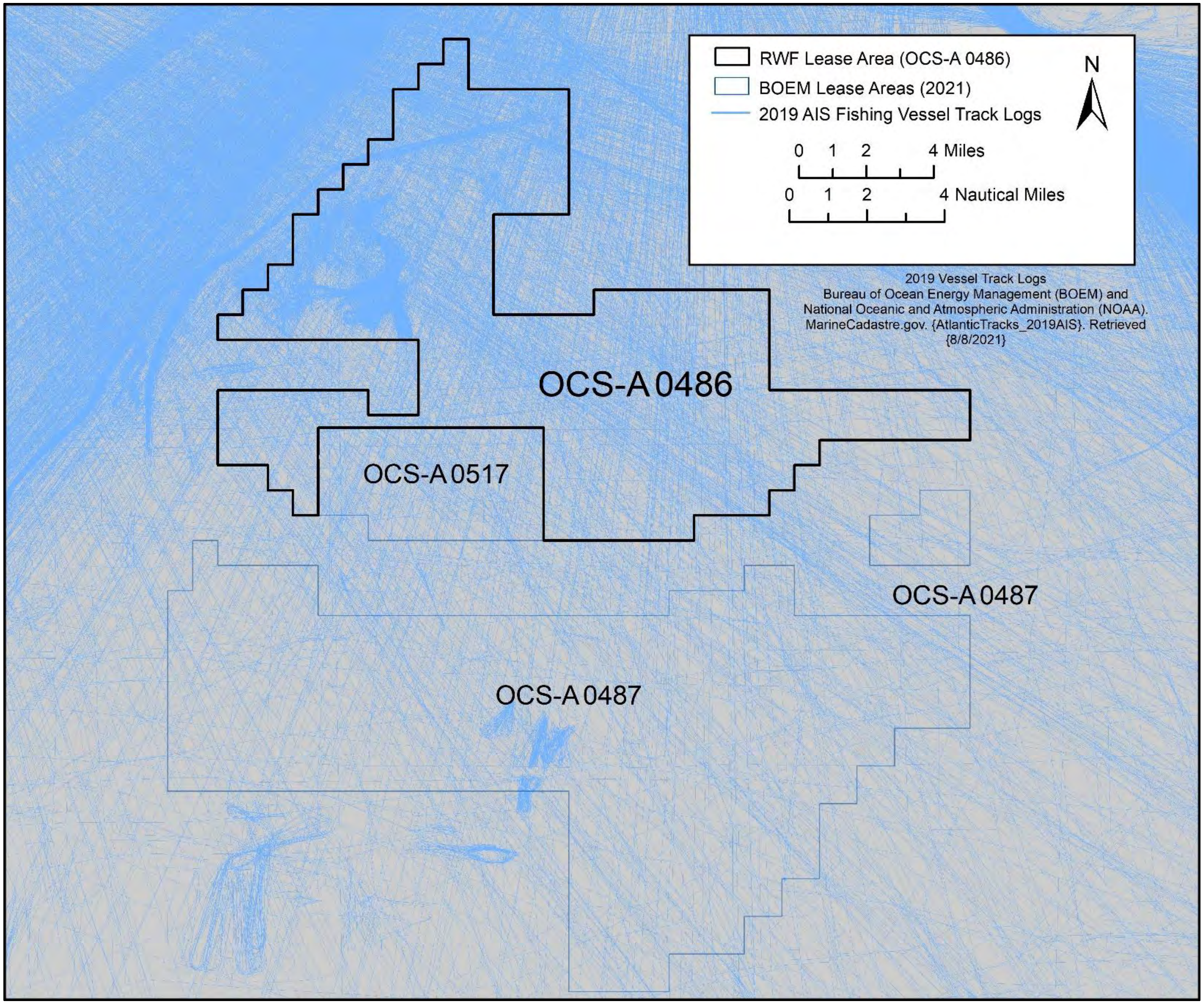

Figure 3.16-3. Detail of fishing vessel traffic near the Lease Area.

3.16.2 Environmental Consequences

3.16.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

This assessment analyzes the maximum-case scenario; however, there is the potential for variances in the proposed Project build-out, as defined in the PDE (see Appendix D). If Revolution Wind implements 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 below.

The relevant design parameters for impacts to navigation and vessel traffic are the number and layout of WTGs and OSSs (i.e., the presence of structures) within the Lease Area. If the number of structures is reduced, the change in impact would be based on the location of the WTGs removed. Removal of rows or columns of structures would have the greatest change in impacts due to the increased navigation space created. Removal of select structures not organized in rows or columns would have less of an impact due to the navigational constraints and layout of the remaining grid pattern. Changes to the layout that move away from a standard 1 × 1–nm grid would increase the navigational complexity and the risk of incidents, including collisions, allisions, and accidental releases.

See Appendix E1 for a summary of IPFs analyzed for navigation and vessel traffic across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have a negligible effect are excluded from Chapter 3 and provided in Table E2-13 in Appendix E1.

Table 3.16-3 provides a comparison of all evaluated IPFs for navigation and vessel traffic across alternatives. Each alternative analysis discussion consists of the construction and installation phase, the O&M phase, the decommissioning phase, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion. Detailed analysis of other considered action alternatives is also provided below the table if analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component.

The conclusion section within each alternative analysis discussion includes rationale for the overall effect call determination.

Under all of the options overall impact to navigation and vessel traffic from any alternative would be long term **moderate** adverse, as impacts would be notable, but the resource would recover completely when the impacting agents are removed and remedial or mitigating actions are taken. Where feasible, calculations for specific alternative impacts are provided in Appendix E4, to facilitate reader comparison across alternatives.

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Table 3.16-3. Alternative Comparison Summary for Navigation and Vessel Traffic

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative G (Preferred Alternative)	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
Anchoring and new cable emplacement/ maintenance	**Offshore**: Anchoring vessels used in the construction of offshore wind energy projects would pose a navigational hazard to vessels. Although anchoring impacts would occur primarily during Project construction, some impacts could also occur during O&M and decommissioning. All impacts would be localized (within a few hundred yards of an anchored vessel) and temporary (hours to days). Impacts on navigation and vessel traffic would be temporary localized **minor** adverse, and navigation and vessel traffic would fully recover following the disturbance. Offshore cable emplacement would have temporary localized **minor** adverse impacts on boating because vessels would need to navigate around work areas, and some boaters would prefer to avoid the noise and disruption caused by installation.	**Offshore**: The Project would have no impact on ordinary anchoring activity in the area. The Project may have some impact on anchoring near the cable route, provided that a vessel might need to anchor in an emergency. Cable laying would have a temporary **negligible** to **minor** adverse impact on vessels entering or exiting commercial shipping lanes and the precautionary area during construction. Impacts of anchoring and new cable emplacement/maintenance on deep draft vessels during operations would be long term **negligible** adverse. BOEM estimates a total of 25,019 acres of cabling- and anchoring-related seafloor disturbance for the Proposed Action plus all other future offshore wind projects in the contiguous RI/MA and MA WEA lease areas. Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the Project would have short-term **minor** to **moderate** adverse cumulative impacts on navigation and vessel traffic.	**Offshore**: Alternatives C through F would reduce the IAC proportionally based on the number of WTGs but would still require cables to connect the extent of the WTGs. The construction impacts from anchoring and new cable emplacement/maintenance would be similar to the Proposed Action. Ordinary anchoring activity would occur outside the Lease Area and not be affected. When combining any of the action alternatives (C–F) with the Proposed Action, anchoring and new cable emplacement/maintenance impacts during construction and installation could be slightly reduced. However, this reduction would not result in a change in the overall impact conclusion when compared to that alternative by itself. Overall, there would be a temporary **negligible** to **minor** adverse impact on vessels entering or exiting commercial shipping lanes and the precautionary area from cable laying and a temporary **moderate** adverse impact on commercial fishing vessels. During operation, as with the Proposed Action, the Project would have no impact on ordinary vessel anchorage operations, although risks would still exist for emergency anchoring and vessels transiting the area at a reduced level due to the smaller footprints. Impacts of anchoring and new cable emplacement/maintenance on deep draft vessels during operations would be long term **negligible** adverse. The alternatives would contribute to the cumulative impacts of offshore wind projects but to a lesser extent than the Proposed Action based on the alternative chosen. The change from Alternatives C through F would be negligible relative to all future activity in the contiguous RI/MA and MA WEA lease areas and it is unexpected that Project cable installation would overlap with other project cable routes. When considered in combination with past, present, and other reasonably foreseeable projects the Project would have short-term **minor** to **moderate** adverse cumulative impacts on navigation and vessel traffic.				**Offshore**: Alternative G's construction impacts from anchoring and new cable emplacement/maintenance would be similar to the Proposed Action. Ordinary anchoring activity would occur outside the Lease Area and not be affected. Anchoring and new cable emplacement/maintenance impacts during construction and installation could be slightly reduced, though this would not result in a change in the overall impact conclusion. Overall, there would be a temporary **negligible** to **minor** adverse impact on vessels entering or exiting commercial shipping lanes and the precautionary area from cable laying, and a temporary **moderate** adverse impact on commercial fishing vessels. During operation, as with the Proposed Action, the Project would have no impact on ordinary vessel anchorage operations, although risks would still exist for emergency anchoring and vessels transiting the area at a reduced level. Impacts of anchoring and new cable emplacement/maintenance on deep draft vessels during operations would be long term **negligible** adverse. The alternatives would contribute to the cumulative impacts of offshore wind projects but to a lesser extent than the Proposed Action. The change would be negligible relative to all future activity in the contiguous RI/MA and MA WEA lease areas, and it is not expected that Project cable installation would overlap with other project cable routes. When considered in combination with past, present, and other reasonably foreseeable projects, the Project would have short-term **minor** to **moderate** adverse cumulative impacts on navigation and vessel traffic.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative G (Preferred Alternative)	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
Port utilization	**Offshore**: Construction and operation of improvements at various ports in support of reasonably foreseeable offshore wind projects could coincide with the forecasted port improvements listed in Appendix E, some of which are intended to directly support offshore wind energy development. Port improvements could increase vessel congestion and stress port capacity during construction, leading to temporary localized **minor** to **moderate** adverse impacts based on how the different projects manage their port utilization.	**Offshore**: Because of the small number of vessels involved with Project construction, any ports potentially used by these vessels would be able to accommodate their needs at existing facilities without significant modifications or upgrades; therefore, the impact to port operations or port congestion would be temporary **negligible** to **minor** adverse. Any ports used by vessels conducting maintenance would have a long-term **negligible** adverse impact because ports potentially used by these vessels would be able to accommodate their needs at existing facilities without significant modifications or upgrades. Project port activity and upgrades (via dredging and in-water work) could coincide with other forecasted projects. Port activities could be delayed or ports could experience congestion or changes in utilization as a result of the overlap in construction activities. Therefore, the cumulative impacts of the Proposed Action when combined with past, present, and reasonably foreseeable future projects would have long-lasting overall but temporary impacts on specific ports (depending on how each project manages its port utilization) with localized **minor** to **moderate** adverse impacts on port utilization.	**Offshore**: Alternatives C through F would reduce the number and duration of vessel activity. Therefore, construction impacts on port utilization would be reduced from the levels of the Proposed Action depending on the alternative chosen, but still temporary **negligible** adverse. Alternatives C through F would reduce the number and duration of vessels working on maintenance activity, although due to the vessels primarily working on-site, the change to port utilization would be negligible. Ports potentially used by these vessels would be able to accommodate their needs at existing facilities without significant modifications or upgrades. Therefore, Alternative C through F would have the same impact from port utilization as the Proposed Action: long term **negligible** adverse. Port upgrades and vessel activity associated with the Project could result in negligible impacts to navigation and vessel traffic. Alternatives C through F would require fewer construction vessels than the Proposed Action and would therefore reduce the potential impact on ports, reducing its share of cumulative impacts, depending on the alternative chosen. However, port activity and upgrades (via dredging and in-water work) could coincide with other forecasted projects, and a reduced footprint relative to the Proposed Action would not likely have much of an impact overall. The cumulative impacts of Alternatives C through F when combined with past, present, and reasonably foreseeable future projects would have long-lasting overall but temporary impacts on specific ports (depending on how each project manages its port utilization), with localized **minor** to **moderate** adverse impacts on port utilization.				**Offshore**: Alternative G would reduce the number and duration of vessel activity. Therefore, construction impacts on port utilization would be reduced from the levels of the Proposed Action, but would still be temporary **negligible** adverse. The alternative would also reduce the number and duration of vessels working on maintenance activity, although due to the vessels primarily working on-site, the change to port utilization would be negligible. Ports potentially used by these vessels would be able to accommodate their needs at existing facilities without significant modifications or upgrades. Therefore, Alternative G would have the same impact from port utilization as the Proposed Action: long term **negligible** adverse. Port upgrades and vessel activity associated with the Project could result in negligible impacts to navigation and vessel traffic. Alternative G would require fewer construction vessels than the Proposed Action and would therefore reduce the potential impact on ports, reducing its share of cumulative impacts, depending on the alternative chosen. However, port activity and upgrades (via dredging and in-water work) could coincide with other forecasted projects, and a reduced footprint relative to the Proposed Action would not likely have much of an impact overall. The cumulative impact of Alternative G when combined with past, present, and reasonably foreseeable future projects would have long-lasting overall but temporary impacts on specific ports (depending on how each project manages its port utilization), with localized **minor** to **moderate** adverse impacts on port utilization.
Presence of structures	**Offshore**: Using the assumptions in Appendix E4, the No Action Alternative would include 81 foundations, with a cumulative total of 1,025 foundations. The	**Offshore**: Revolution Wind would develop a mariner communication plan, limit construction activities to periods of good weather, and request the USCG implement temporary safety zones	**Offshore**: As with the Proposed Action, Revolution Wind would develop a mariner communication plan, limit construction activities to periods of good weather conditions, and request the USCG implement temporary safety zones around the locations with active construction. In addition to the reduced footprint, depending on the option(s) chosen, this				**Offshore**: As with the Proposed Action, Revolution Wind would request the USCG implement temporary safety zones around the locations with active

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative G (Preferred Alternative)	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
	placement of these structures in the contiguous RI/MA WEA and MA WEA lease areas would have long-term **negligible** to **moderate** adverse impacts on vessels through the risk of allision, navigation hazards, space-use conflicts, the presence of cable infrastructure, and visual impacts.	around the locations with active construction. This would minimize impacts from offshore RWEC construction. The impact would be temporary and increase from **negligible** to **moderate** adverse as structures are added. For vessels that generally travel within and through the Lease Area, a vessel's view could be obstructed for as much as 7.8 seconds. Because of the 1 × 1–nm spacing of the Project structures, the impact on visibility would be further reduced. The Project would use USCG-approved lighting to make nearby vessels aware of structure locations (see Appendix F for EPMs). The structures would not impact a mariner's ability to use navigation aids or the coastline as a reference for navigation. Overall, spacing and placement of the structures would result in a long-term **negligible** adverse impact to visibility and a long-term **moderate** adverse impact from the presence of structures due to increased navigational complexity and allision risk. The Proposed Action would add up to 100 additional WTGs and two OSSs to the No Action Alternative's 1,015 cumulative structures, which would increase navigational complexity and therefore the risk of collision, allision, and potential spills. Additional structures could also interfere with marine radars and aircraft engaging in search and rescue efforts. The Proposed Action would more than double the number of existing structures, though it would account for 10% of the total future structures in the contiguous RI/MA and MA WEA lease areas and would implement a 1 × 1–nm uniform north–south and east–west grid spacing, consistent with other contiguous RI/MA and MA WEA lease areas. The cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would consist predominantly of impacts described under the No Action Alternative, which would represent a long-term **moderate** adverse impact on navigation and vessel traffic.	would minimize impacts from offshore RWEC construction (see Appendix F). Due to controls in the working area, Alternatives C through F would have impacts slightly reduced but similar to the Proposed Action for the presence of structures: temporary and increasing from **negligible** to **moderate** adverse as structures are added. The removal of structures from the northern and northwestern sections of the Lease Area under Alternative E would, in particular, move construction activity away from areas with the greatest commercial fishing activity, resulting in a temporary impact on commercial fishing vessel navigation that would increase from **negligible** to **minor** adverse as structures are added during construction. Fishing activity would see the greatest reduction in impacts relative to the Proposed Action. During operations, Alternatives C through F would reduce the number of WTGs in the Lease Area, which would alleviate some navigational complexity in areas where WTGs are not present. Detailed analysis is provided in Section 3.16.2.3. Alternatives C through F would add to the 81 structures present under the No Action Alternative and 1,025 total cumulative structures including future offshore wind energy projects, which would increase navigational complexity; increase the risk of collision, allision, and potential spills; and potentially interfere with marine radar or aircraft conducting search and rescue efforts. See Section 3.17 (Other Uses) for a discussion of potential impacts to search and rescue efforts. The footprint of each alternative would have varying impacts on these activities based on other actions. Detailed analysis is provided in Section 3.16.2.3.				construction, develop a mariner communication plan, and limit construction activities to periods of good weather conditions. In addition to the reduced footprint, this would minimize impacts from offshore RWEC construction (see Appendix F). Due to controls in the working area, Alternative G would have impacts slightly reduced but similar to the Proposed Action for the presence of structures: temporary and increasing from **negligible** to **moderate** adverse as structures are added. The removal of structures from the southwest section of the Lease Area would move construction activity away from areas with some commercial fishing traffic, resulting in a temporary impact on commercial fishing vessel navigation that would increase from **negligible** to **minor** adverse as structures are added during construction. Fishing activity would see a small reduction in impacts relative to the Proposed Action. During operations, Alternative G would reduce the number of WTGs in the Lease Area relative to the Proposed Action, which would alleviate some navigational complexity in areas where WTGs are not present, resulting in long term **minor** to **moderate** adverse impacts. Detailed analysis is provided in Section 3.16.2.3. The alternative would add to the 81 structures present under the No Action Alternative, which would increase navigational complexity; increase the risk of collision, allision, and potential spills; and potentially interfere with marine radar or aircraft conducting search and rescue efforts. See Section 3.17 (Other Uses) for a discussion of potential impacts to search and rescue efforts. The footprint of each alternative would have varying impacts on these activities based on other actions. Detailed analysis is provided in Section 3.16.2.3.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative G (Preferred Alternative)	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
							The cumulative impacts associated with the Preferred Action would be similar to that of the Proposed Action: long term **moderate** adverse on navigation and vessel traffic.
Vessel traffic	**Offshore**: Vessel activity could peak in 2025, with as many as 210 vessels involved in the construction and operation of current and reasonably foreseeable projects (see Table 3.16-4). Construction activities would result in increased vessel traffic near the lease areas and ports used as well as obstructions to navigation and changes to navigation patterns. Additional impacts would include delays within or approaching ports; increased navigational complexity; detours to offshore travel or port approaches; or increased risk of incidents such as collision, strikes or allisions, and groundings. As a whole, this level of traffic activity would represent a long-term overall but temporary **minor** to **moderate** adverse impact on individual ports and a **minor** to **moderate** adverse impact to navigation under the No Action Alternative because the construction would be located outside major shipping lanes and the number of vessels would be small compared to the overall level of traffic near each of the potential developments. The vessels impacted under this alternative would be primarily commercial fishing and other types of vessels that have historically transited to and operated within or near each of the potential developments.	**Offshore**: Project effects on navigation and vessel traffic would include increased vessel traffic near the RWF, offshore RWEC, and ports used by the Project; obstructions to navigation; delays within or approaching ports; increased navigational complexity; changes to navigation patterns; detours to offshore travel or port approaches; or increased risk of incidents such as allisions. There would be a short-term **minor** adverse impact on deep draft, tug, and towing vessels and commercial fishing vessels would experience temporary **moderate** adverse impacts. Because of the small number of vessels involved in construction, Project construction would have a temporary (for the duration of construction activities) **negligible** adverse impact on commercial traffic as a whole. Maintenance would have a long-term **negligible to minor** adverse impact on navigation and vessel traffic because of the infrequent nature of monitoring and inspection. Maintenance would primarily impact commercial fishing and other vessels operating at the same time and place that maintenance is performed. Because of the low frequency of allision and collision incidents and Project EPMs, the expected risks to navigation would be long term **negligible** adverse. Decommissioning of the Project would have similar short-term (for the duration of decommissioning activities) **minor** to **moderate** adverse impacts as construction. The Proposed Action would add as many as 56 construction vessels during construction in 2024 and 2025 to conditions under the No Action Alternative. BOEM estimates a peak of 259 vessels at sea on a daily basis due to offshore wind Project construction and O&M over a 10-year time frame, with most of these vessels remaining in the vicinity of their respective lease areas. Therefore, cumulative impacts associated with the Project when combined with past, present,	**Offshore**: As with the Proposed Action, Project construction could impact navigation and vessel traffic. Project effects on navigation and vessel traffic would include increased vessel traffic near the RWF, offshore RWEC, and ports used by the Project; obstructions to navigation; delays within or approaching ports; increased navigational complexity; changes to navigation patterns; detours to offshore travel or port approaches; or increased risk of incidents such as allisions. These impacts would be reduced proportionally with the smaller footprint on the chosen alternative due to a smaller area under construction. Alternatives D3 and E2 have a reduced potential for affecting vessel traffic by extending the buffer around and moving construction away from the traffic separation scheme. Likewise, the combinations of D1+D3 and D1+D2+D3 would have reduced potential for affecting vessel traffic. Construction of offshore components of the Project under Alternatives C through F would likely require less time than anticipated for the Proposed Action (see COP Section 3.2). The NSRA indicates the highest risk would be from smaller non-Project vessels operating close to construction and work vessels; this risk would be reduced based on the smaller footprint (DNV GL Energy USA, Inc. 2020). There would be a temporary (for the duration of construction activities) minor adverse impact on smaller vessels, which would need to reroute around the Project. Commercial fishing vessels would experience temporary moderate adverse impacts. However, because of the small number of vessels involved in construction and due to controls in the working area, Project construction would have a temporary (for the duration of construction activities) **negligible** adverse impact on commercial traffic as a whole. Operational impacts to navigation would be reduced from the Proposed Action in vessel traffic, though not meaningfully so, due to the decreased footprint of Alternatives C through F and removal of structures from the trafficked areas. All alternatives would still be located within the Lease Area and would primarily affect vessels that normally would be present, in particular, fishing vessels. Most vessel transits would take place outside the Lease Area; impacts due to the presence of structures are addressed above. Overall, the net effect is that Alternatives C through F would have the same impact from vessel traffic as the Proposed Action: long term **negligible** adverse. Decommissioning of the Project under Alternatives C through F would have similar short-term (for the duration of decommissioning activities) **minor** to **moderate** adverse impacts as construction because decommissioning would use similar numbers of vessels and implement the same EPMs. After the Project is decommissioned, the navigation conditions in the area would return to pre-Project conditions pursuant to 30 CFR 585.910. Alternatives C through F would add construction vessels in 2024 and 2025 to conditions under the No Action Alternative at a level proportionally lower than the maximum-case scenario under the Proposed Action based on the alternative chosen. Non-Project traffic would largely avoid the work area and transiting construction vessels, with potentially fewer adjustments needed based on the vessels' routes and the reduced work area. Project O&M vessel traffic under Alternatives C through F would be less than that of the Proposed Action. When compared to all future activities considered in this analysis, these reductions in the Project's impact would cause a meaningful reduction in cumulative impacts. The reduction would to some extent depend on the actions taken by other future activities. Alternative D1, for example, would result in less of a				**Offshore**: As with the Proposed Action, Project construction could impact navigation and vessel traffic. Project effects on navigation and vessel traffic would include increased vessel traffic near the RWF, offshore RWEC, and ports used by the Project; obstructions to navigation; delays within or approaching ports; increased navigational complexity; changes to navigation patterns; detours to offshore travel or port approaches; or increased risk of incidents such as allisions. These impacts would be reduced proportionally with the smaller footprint on the chosen alternative due to a smaller area under construction. Alternative G would have a slightly reduced potential for affecting vessel traffic by eliminating WTGs in the southwest portion of the Lease Area. Construction of offshore components of the Project would likely require less time than anticipated for the Proposed Action. The NSRA indicates the highest risk would be from smaller non-Project vessels operating close to construction and work vessels; this risk would be reduced based on the smaller footprint (DNV GL Energy USA, Inc. 2020). There would be a temporary (for the duration of construction activities) **minor** adverse impact on smaller vessels, which would need to reroute around the Project. Commercial fishing vessels would experience temporary **moderate** adverse impacts. However, because of the small number of vessels involved in construction and due to controls in the working area, Project construction would have a temporary (for the duration of

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTG	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative G (Preferred Alternative)	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
		and reasonably foreseeable future activities would be short term **minor** adverse.	reduction in impacts if an adjacent lease area were to be developed to its full extent than it would if that development were to accommodate the proposed transit location. Therefore, Alternatives C through F would result in a minor adverse cumulative impact to vessel traffic and, when combined with past, present, and reasonably foreseeable future activities, an overall short- to long-term **minor** adverse cumulative impact.				construction activities) **negligible** adverse impact on commercial traffic as a whole. Operational impacts to navigation would be reduced from the Proposed Action in vessel traffic, though not meaningfully so, due to the slightly reduced footprint. The Project would primarily affect vessels that normally would be present in the Lease Area, in particular, fishing vessels. Most vessel transits would take place outside the Lease Area; impacts due to the presence of structures are addressed above. Overall, the net effect is that Alternative G would have the same impact from vessel traffic as the Proposed Action: long term **negligible** adverse. Decommissioning of the Project under Alternative G would have similar short-term (for the duration of decommissioning activities) **minor** to **moderate** adverse impacts as construction because decommissioning would use similar numbers of vessels and implement the same EPMs. After the Project is decommissioned, the navigation conditions in the area would return to pre-Project conditions pursuant to 30 CFR 585.910. Alternative G would add construction vessels in 2024 and 2025 to conditions under the No Action Alternative at a level lower than the Proposed Action. Non-Project traffic would largely avoid the work area and transiting construction vessels, with potentially fewer adjustments needed based on the vessels' routes and the reduced work area. Project O&M vessel traffic would be less than that of the Proposed Action. Alternative G would result in a **minor** adverse cumulative impact to vessel traffic and, when combined with past, present, and reasonably foreseeable future activities, an overall short- to long-term **minor** adverse cumulative impact.

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3.16.2.2 Alternative A: Impacts of the No Action Alternative on Navigation and Vessel Traffic

3.16.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for navigation and vessel traffic (see Section 3.16.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the geographic analysis area. These IPFs are described and analyzed in Appendix E1.

3.16.2.2.2 Cumulative Impacts

This section discloses potential cumulative navigation impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

Anchoring and new cable emplacement/maintenance: BOEM estimates approximately 3,848 acres of seafloor would be disturbed by anchoring associated with offshore wind activities. Anchoring vessels used in the construction of offshore wind energy projects would pose a navigational hazard to vessels. Although anchoring impacts would occur primarily during Project construction, some impacts could also occur during O&M and decommissioning. All impacts would be localized (within a few hundred yards of an anchored vessel) and temporary (hours to days). Therefore, the effects of offshore wind energy–related anchoring on commercial fisheries and for-hire recreational fishing are expected to be short term **minor** adverse.

Future offshore wind developers are expected to coordinate with the maritime community and the 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 schemes. 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 to the vessel 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 localized **minor** adverse, and navigation and vessel traffic would fully recover following the disturbance.

Under the No Action Alternative, up to 2,952 miles of cable could be installed in the contiguous RI/MA WEA and Massachusetts Wind Energy Area (MA WEA) lease areas to support future offshore wind projects (see Figure 1.1-2 for location of RI/MA and MA WEAs). Offshore cable emplacement would have temporary localized **minor** adverse impacts on boating because vessels would need to navigate around work areas, and some boaters would prefer to avoid the noise and disruption caused by installation.

Port utilization: Construction and operation of improvements at various ports in support of reasonably foreseeable offshore wind projects could coincide with the forecasted port improvements listed in Appendix E, some of which are intended to directly support offshore wind energy development. Port improvements could increase vessel congestion and stress port capacity during construction, leading to temporary localized **minor** to **moderate** adverse impacts based on how the different projects manage their port utilization. However, state and local agencies would be responsible for minimizing the potential adverse impacts of additional port utilization by managing traffic to ensure continued access to ports.

Presence of structures: Using the assumptions in Appendix E3, future offshore wind energy projects under the No Action Alternative would include 1,015 foundations. The placement of these structures in the contiguous RI/MA WEA and MA WEA lease areas would have long-term adverse impacts on vessels through the risk of allision, navigation hazards, space-use conflicts, the presence of cable infrastructure, and visual impacts. While lease areas are generally located in low vessel traffic areas, they do receive some use. Table 3.16-1 summarizes the miles traveled by vessels within the Lease Area and other lease areas in 2019.

The presence of offshore wind structures would increase the GAA's navigational complexity, thereby increasing the risk of allision or collision. Deep draft, tug, and towing vessels would need to minimally divert to avoid traveling near structures. Vessels that generally travel within and through lease areas could require an adjustment of navigation practices. The attraction of artificial reef effects would increase vessel congestion and the risk of allision, collision, and spills near structures. BOEM assumes that all offshore wind developments in the GAA would use the developer-agreed-upon 1 × 1–nm spacing in fixed east–west rows and north–south columns and would evaluate each of those individual projects in their respective NEPA analyses. Because this layout supports traditional east–west active fishing operations, this arrangement would reduce, but not eliminate, navigational complexity and space-use conflicts during the operations phases of the projects.

Vessel traffic: Applying vessel activity estimates developed by BOEM based on its 2019 study *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Outer Continental Shelf* (BOEM 2019) and applying construction vessel activity estimates presented in *Vineyard Wind I Offshore Wind Energy Project Final Environmental Impact Statement Volume I* (BOEM 2021), if construction of the Project does not occur, vessel activity could peak in 2025, with as many as 210 vessels involved in the construction and operation of current and reasonably foreseeable projects (Table 3.16-4).

Table 3.16-4. Cumulative Construction and Operations Vessels from Current and Future Activities

Vessels	2021	2022	2023	2024	2025	2026	2027
Average construction vessels	1	0	72	106	102	16	0
Maximum construction vessels	1	0	132	194	188	28	0
Average operations vessels	1	1	1	3	8	12	12
Maximum operations vessels	1	1	1	9	22	34	36
Average daily vessels, total	2	1	73	109	110	28	12
Maximum daily vessels, total	2	1	133	203	210	62	36

Source: Developed using offshore wind projects listed in Table E-1 in Appendix E and estimates of average (maximum) daily vessels per foundation of 0.245 (0.451) for construction and 0.010 (0.029) for operations from BOEM (2021).

Construction activities would result in increased vessel traffic near the lease areas and ports used as well as obstructions to navigation and changes to navigation patterns. Additional impacts would include delays within or approaching ports; increased navigational complexity; detours to offshore travel or port approaches; or increased risk of incidents such as collision, strikes or allisions, and groundings. Other reasonably foreseeable future offshore projects would produce additional vessel traffic during construction, but because of their timing, they are not anticipated to use the same traffic routes. Construction of other offshore wind projects are anticipated to be scheduled to minimize overlapping construction periods and reduce the number of construction vessels in operation at any given time, effectively reducing the cumulative impact on port congestion and construction vessel rerouting. As a whole, this level of traffic activity would represent a long-term overall but temporary **minor** to **moderate** adverse impact on individual ports and a **minor** to **moderate** adverse impact to navigation under the No Action Alternative because the construction would be located outside major shipping lanes and the number of vessels would be small compared to the overall level of traffic near each of the potential developments.

Cumulative impacts during O&M of reasonably foreseeable offshore wind projects (see Table 3.16-3) would also represent a long-term **negligible** to **minor** adverse impact to navigation due to the smaller number of vessels and lower frequency of activities (growing to an average of 12 vessel trips per day by 2027). Decommissioning of each of the projects is anticipated to have cumulative impacts similar to those experienced during construction. All reasonably foreseeable offshore wind projects would be required to prepare an NSRA in compliance with the guidelines in USCG NVIC 01-19 (USCG 2019), which would serve to minimize impacts to marine navigation.

3.16.2.2.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on navigation associated with the Project would not occur. However, ongoing and future activities would have continuing temporary to long-term **minor** to **moderate** impacts on navigation, primarily through existing traffic activity, port use, and the presence of structures.

BOEM anticipates that the range of impacts for reasonably foreseeable offshore wind activities, especially the presence of structures, port utilization, and vessel traffic, would be long term minor to moderate adverse. As described in Appendix E1, BOEM anticipates that the range of impacts for ongoing activities and reasonably foreseeable activities other than offshore wind would also be long term minor to moderate adverse. Future projects would increase vessel activity, which could lead to congestion at affected ports, the possible need for port upgrades beyond those currently envisioned, and an increased likelihood of collisions and allisions, with a resultant increased risk of accidental releases. In addition, the presence of new structures would also increase the risk for collisions, allisions, and resultant accidental releases and threats to human health and safety.

Considering all the IPFs together, BOEM anticipates that the impacts associated with future offshore wind activities in the GAA combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in long-term **minor** to **moderate** adverse impacts because the overall effect would be notable, but vessels would be able to adjust to account for disruptions and EPMs would reduce impacts.

3.16.2.3 Alternative B: Impacts of the Proposed Action on Navigation and Vessel Traffic

3.16.2.3.1 Construction and Installation

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: The nearest anchorage area is 6.7 nm from the Project (DNV GL Energy USA, Inc. 2020:Section 2.2.2.5), and the Project would have no impact on ordinary anchoring activity in the area. The Project may have some impact on anchoring near the cable route, provided that a vessel might need to anchor in an emergency. Cable laying would have a temporary **negligible** to **minor** adverse impact on vessels entering or exiting commercial shipping lanes and the precautionary area.

Port utilization: Because of the small number of vessels involved with Project construction, any ports potentially used by these vessels would be able to accommodate their needs at existing facilities without significant modifications or upgrades; therefore, the impact to port operations would be temporary **negligible** to **minor** adverse. See Section 3.11 for a list of potential port facilities the Project could use and how they would be used. There would be a temporary **negligible** to **minor** adverse impact on port congestion.

Presence of structures: Revolution Wind would develop a mariner communication plan, limit construction activities to periods of good weather conditions, and request the USCG implement temporary safety zones around the locations with active construction (see Table F-1 in Appendix F). This would minimize impacts from offshore RWEC construction, though the addition of 100 structures would more than double the 81 structures under the No Action Alternative. The impact would be temporary and increase from **negligible** to **moderate** adverse as structures are added.

Vessel traffic: Project construction could impact navigation and vessel traffic. Project effects on navigation and vessel traffic would include increased vessel traffic near the RWF, offshore RWEC, and ports used by the Project; obstructions to navigation; delays within or approaching ports; increased navigational complexity; changes to navigation patterns; detours to offshore travel or port approaches; or increased risk of incidents such as allisions.

Construction of offshore components of the Project would require approximately 8 months for the RWEC, 5 months for WTG foundations, 5 months for the IAC, 8 months for WTGs, and 8 months for OSSs (see Chapter 2, Figure 2.1-9). The NSRA indicates the highest risk would be from smaller non-Project vessels operating close to construction and work vessels. Because of the small number of vessels used for construction and the location of the Project outside shipping lanes (see Figures 3.16-2 and 3.16-3), there would be a short-term (for the duration of construction activities) **minor** adverse impact on deep draft, tug, and towing vessels, which would need to reroute around the Project for a slightly longer route, and smaller passenger vessels, which could reroute closer to shore, increasing grounding potential. During construction and installation, commercial fishing vessels would need to avoid work areas and could be adversely impacted, depending on the location of the exploitable biomass and whether there are suitable alternative locations; with respect to navigation, commercial fishing vessels would experience temporary **moderate** adverse impacts. Because of the small number of vessels involved in construction, Project construction would have a temporary (for the duration of construction activities) **negligible** adverse impact on commercial traffic as a whole.

3.16.2.3.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: The nearest anchorage area is 6.7 nm away from the Project (DNV GL Energy USA, Inc. 2020:Section 2.2.2.5), and the Project would have no impact to ordinary vessel anchorage operations, although risks would still exist for emergency anchoring and vessels transiting the area. Impacts of anchoring and new cable emplacement/maintenance on deep draft vessels during operations would be long term **negligible** adverse.

Port utilization: Any ports used by vessels conducting maintenance would have a long-term **negligible** adverse impact because ports potentially used by these vessels would be able to accommodate their needs at existing facilities without significant modifications or upgrades.

Presence of structures: For vessels that generally travel within and through the Lease Area, the NSRA mapped out the placement of the structures and evaluated the time of potential visual obstruction each would present based on a vessel's speed (DNV GL Energy USA, Inc. 2020:Section 9). At a speed of 5 knots, a vessel's view could be obstructed for as much as 7.8 seconds. The NSRA notes that this is a conservative estimate because it reflects the view of a single moving vessel and not multiple moving vessels that would enhance each vessel's ability to see the others. Because of the 1 × 1–nm spacing of the Project structures, the impact on visibility would be further reduced. The Project would use USCG-approved lighting to make nearby vessels aware of structure locations (see Appendix F for EPMs). The structures would not impact a mariner's ability to use navigation aids or the coastline as a reference for navigation. Overall, spacing and placement of the structures would result in a long-term **negligible** adverse impact to visibility. NOAA also would identify and chart the structures and offshore RWEC.

Under the Proposed Action, there is a modeled increase of 1.4 incidents per year in the NSRA's study area over baseline conditions as a result of changes to travel patterns to certain vessel types (DNV GL Energy USA, Inc. 2020:Table 11-2). More than 99% of total incidents would be allisions, and 92% of total incidents would involve fishing vessels. Based on the NSRA results, there would be a negligible increase (0.004) in collisions.

The Project calls for a standard and uniform grid pattern with 1-nm spacing between structures (WTGs and OSSs) across the contiguous RI/MA and MA WEA lease areas, which provides sufficient space for certain vessels that fish in the RI/MA and MA WEAs to continue fishing after the wind farms are constructed. See Figure 1.1-2 for location of the RI/MA and MA WEAs. The USCG has determined that if structures are developed along a standard and uniform grid pattern, formal or informal vessel routing measures would not be required because such a grid pattern would provide space for dispersal of the fleet that can safely accommodate both transits through and fishing within the RI/MA and MA WEAs. The USCG believes the 1 × 1–nm aligned and gridded layout should be sufficient to maintain navigational safety and provide vessels with multiple straight-line options to transit safely throughout the contiguous RI/MA and MA WEA lease areas (USCG 2020). Marine vessel radars are not optimized to operate in a WTG environment due to a combination of factors ranging from the slow adoption of solid-state technology to the electromagnetic characteristics of WTGs (National Academies of Sciences, Engineering, and Medicine 2022). USCG also noted in its final *The Areas Offshore of Massachusetts and Rhode Island Port Access Route Study* (USCG 2020) that various factors play a role in potential marine radar interference by offshore wind infrastructure, stating that "the potential for interference with marine radar is site specific and depends on many factors including, but not limited to, turbine size, array layouts, number of turbines, construction material(s), and the vessel types." It is anticipated that industry will adopt both technological and non-technological-based measures to reduce impacts on marine radar, including greater use of AIS and electronic charting systems, use of new technologies like LiDAR, employing more watchstanders, and avoiding wind farms altogether.

The USCG has reviewed all available studies on radar interference and found that although these studies show that structures could have some effect upon radar, as discussed in the MARIPARS report, they do not render radar inoperable and do not inform planning decisions about structure arrangement or spacing (USCG 2020).

Overall, as the number of structures increases from 81 under the No Action Alternative to 181 structures under the Proposed Action, there would be a long-term **moderate** adverse impact from the presence of structures due to increased navigational complexity and allision risk.

Vessel traffic: During operations, maintenance is expected on a periodic basis for each offshore component (offshore transmission facilities, WTG and OSS foundations, and WTGs) (see COP Sections 3.5.2 through 3.5.4). This limited operation activity would have a long-term **negligible to minor** adverse impact on navigation and vessel traffic, with impacts primarily on commercial fishing and other vessels operating at the same time and place as maintenance vessels.

Because of the low frequency of allision and collision incidents and Project EPMs (see Table F-1 in Appendix F), the expected risks to navigation would be long term **negligible** adverse. Most deep draft vessel traffic already avoids the area and would not need to meaningfully reroute, as shown in Figures 3.16-2 and 3.16-3. The Project is outside existing traffic lanes and is not expected to require significant rerouting of traffic to avoid Project components (DNV GL Energy USA, Inc. 2020:Table 5-1).

Impacts to traffic from offshore RWEC maintenance would be temporary **negligible** adverse because of the infrequent nature of monitoring and inspection. Decommissioning of the Project would have similar short-term (for the duration of decommissioning activities) **minor** to **moderate** adverse impacts as construction because decommissioning would use similar numbers of vessels and implement the same EPMs. After the facility is decommissioned, the navigation conditions in the area would return to pre-Project conditions.

3.16.2.3.3 Cumulative Impacts

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: The Proposed Action would add up to 7,213 acres of seafloor disturbance from RWEC, OSS-link, IAC installation, and anchoring/mooring activity to the seafloor cable–related disturbance estimated under the No Action Alternative. This would result in localized temporary **minor** adverse cumulative impacts on navigation and vessel traffic due to increased collision and spill risk during construction. BOEM estimates a total of 25,019 acres of seafloor disturbance for the Proposed Action plus all other future offshore wind projects in the GAA. During installation and maintenance, other vessels could also be forced to reroute to avoid installation and maintenance vessels. Cable installation for the Project is not expected to overlap with other project cable routes or installation based on the location of other offshore wind projects and proposed construction schedules (see Appendix E). Therefore, when considered in combination with past, present, and other reasonably foreseeable projects, the Project would have short-term **minor** to **moderate** adverse cumulative impacts on navigation and vessel traffic.

Port utilization: Port upgrades and vessel activity associated with the Proposed Action could result in negligible impacts to navigation and vessel traffic. The Proposed Action is expected to require as many as 56 construction vessels during construction in 2024 (primarily) and 2025 (see COP Table 3.3.10-2 and COP Figure 3.2-1). There would be 1,400 vessel return trips (see COP Table 3.3.10-2), although most vessels would be concentrated in the work area, with fewer vessels transporting crew and materials back and forth from ports. This additional vessel traffic could cause delays or changes in berthing patterns at primary ports. It could lead to operators being redirected to use alternate ports or facilities on a temporary basis. To some extent, individual ports could independently undertake facility improvement projects in anticipation of this demand to relieve some of the potential congestion. The Project's impact on port capacity would also be limited due to the small number of additional vessels.

Project port activity and upgrades (via dredging and in-water work) could coincide with other forecasted projects. Port activities could be delayed or ports could experience congestion or changes in utilization as a result of the overlap in construction activities. Therefore, the cumulative impacts of the Proposed Action when combined with past, present, and reasonably foreseeable future projects would have long-lasting overall but temporary impacts on specific ports (depending on how each project manages its port utilization) with localized **minor** to **moderate** adverse impacts on port utilization.

Presence of structures: The Proposed Action would add up to 100 additional WTGs and two OSSs to the 1,015 structures present under the No Action Alternative, which would increase navigational complexity and therefore the risk of collision, allision, and potential spills. Additional structures could also interfere with marine radars and aircraft engaging in search and rescue efforts. See Table 3.16-1 for a summary of miles traveled by vessels carrying AIS within the Lease Area and other lease areas in 2019. The commercial fisheries discussion in Appendix G presents VMS numbers for commercial fishing vessels. The Proposed Action would account for 10% of the total future structures in the GAA; however, Revolution Wind would implement a 1 × 1–nm uniform north–south and east–west grid spacing, consistent with other contiguous RI/MA and MA WEA lease areas. Therefore, the Project would contribute a long-term **moderate** adverse impact from the presence of structures due to increased navigational complexity and allision risk. The cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would consist predominantly of impacts described under the No Action Alternative, which would represent a long-term **moderate** adverse impact on navigation and vessel traffic.

Vessel traffic: The Proposed Action would add as many as 56 construction vessels during construction in 2024 and 2025 to conditions under the No Action Alternative (see COP Table 3.3.10-2). The Proposed Action represents up to 22% of the total maximum vessels potentially present in 2024. Non-Project traffic would be able to adjust routes and avoid the work area and transiting construction vessels. Project O&M vessel traffic would be substantially less because the RWF would represent 10% of the WTGs in service by 2027 under the No Action Alternative, all of which are assumed to have similar O&M vessel traffic generation. Therefore, the Proposed Action would result in a **minor** adverse impact to vessel traffic. BOEM estimates a peak of 259 vessels at sea on a daily basis due to offshore wind Project construction and O&M over a 10-year time frame, with most of these vessels remaining in the vicinity of their respective lease areas. Therefore, cumulative impacts associated with the Project when combined with past, present, and reasonably foreseeable future activities would be short term **minor** adverse.

3.16.2.3.4 Conclusions

Project construction and installation, O&M, and decommissioning would impact navigation and vessel traffic, primarily through increased traffic; obstructions to navigation; delays within or approaching ports; increased navigational complexity; changes to navigation patterns; detours to offshore travel or port approaches; or increased risk of incidents such as collision, strikes, or allisions, and groundings. BOEM anticipates the impacts resulting from the Proposed Action alone would be long term **moderate** adverse. Therefore, BOEM expects the overall impact on navigation from the Proposed Action alone to be long term **moderate** adverse.

In the context of other reasonably foreseeable environmental trends and planned actions, the impacts under the Proposed Action resulting from individual IPFs would range from temporary to long term **negligible** to **moderate** adverse. The main IPF of concern is the presence of structures, which increase navigational complexity and therefore the risk of collision/allision. Considering all the IPFs together, BOEM anticipates that the overall impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would result in long-term **moderate** adverse impacts to navigation. The overall effect to navigation and vessel traffic would be notable, but the resource would recover completely when the impacting agents are removed and remedial or mitigating actions are taken.

3.16.2.4 Alternatives C, D, E, and F

3.16.2.4.1 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Presence of structures: The Habitat Alternative would reduce the number of WTGs in the central area of the Lease Area, which would alleviate some navigational complexity around that area, where WTGs are not present. However, the presence of an OSS in the center of the area that would otherwise be clear of WTGs (under both C1 and C2) would introduce some complexity, and the presence of three WTGs to the northeast of the OSS (under C2) would create further complexity. Further, the presence of structures in the adjacent OCS-A 0517 lease area could create navigational issues. Overall, the net effect is that Alternative C (under both C1 and C2) would have a slightly reduced impact from the presence of structures from the Proposed Action: long term **minor** to **moderate** adverse.

For the Transit Alternative, Alternative D1 would result in a long-term **moderate** adverse impact from the increased navigational complexity and allision risk. Alternative D2 would result in a long-term **minor** to **moderate** adverse impact from the increased navigational complexity and allision risk, specifically reducing impacts on the fishing and passenger vessels that transit through this area, as it would remove an "ungrouped" section of structures, making navigation through this area more predictable. Alternative D3 would result in a long-term **minor** to **moderate** adverse impact from the presence of structures due to the increased navigational complexity and allision risk. Alternative D3 would result in a somewhat reduced impact from the Proposed Action (although not enough to change the impact rating), as it would remove structures adjacent to the inbound lane of the Buzzards Bay Traffic Separation Scheme that fall within the USCG's Marine Planning Guidelines buffers (USCG 2019). This would reduce risks specifically to commercial and international vessels (e.g., deep draft cargo and tanker). Alternatives D1+D2, D1+D3, and D1+D2+D3 would have a long-term **minor** to **moderate** adverse impact from the presence of structures.

For the Viewshed Alternative, Alternative E2 would expand the traffic separation scheme buffer from 1 nm to 2 nm, reducing the potential for conflict with vessel traffic. Overall, spacing and placement of the structures would result in a long-term **minor** to **moderate** adverse impact to visibility, although navigational complexity would increase from the concentration of traffic in the open area and increase the likelihood that fishing activities will occur there. This could lead to conflicting uses and, accordingly, increased risk of allision/collision. Removal of structures under this alternative would primarily affect commercial fishing vessels, which are active in the area. Alternatives E1 and E2 would reduce impacts to fishing vessels and would result in a long-term **minor** adverse impact to fishing vessel navigation from the presence of structures due to the increased allision risk.

For the Higher Capacity Turbine Alternative, the presence of structures impacts during operations and maintenance and decommissioning could be slightly reduced but similar to the Proposed Action (long term **moderate** adverse) depending on the alternative (C, D, or E) chosen and the location(s) of foundations affected by the reduction.

3.16.2.4.2 Cumulative Impacts

Offshore Activities and Facilities

Presence of structures: The Habitat Alternative would create an apparent passage through the middle of the Lease Area along a northeast–southwest route, which could encourage traffic to transit through that area. Therefore, Alternative C (under both C1 and C2) would have the same cumulative impact from presence of structures as the Proposed Action: long term **moderate** adverse.

For the Transit Alternative, under Alternative D1, the fishing industry–proposed transit lane intersects four contiguous BOEM lease areas: OCS-A 0486 (RWF), OCS-A 0487, OCS-A 0500, and OCS-A 0517.[47] If a similar east–west opening were to be incorporated into the selected alternatives for proposed wind energy projects in the OCS-A 0487, OCS-A 0500, and OCS-A 0517 lease areas, it would reduce the number of structures but may also increase navigational complexity by concentrating traffic in the open area and increasing the likelihood that fishing activities will occur there. This could lead to conflicting uses and, accordingly, increased risk of allision/collision, resulting in a long-term moderate adverse impact on navigation. However, if any of those other lease areas are approved with wind energy project configurations that do not incorporate a similar opening, Alternative D1 would increase the navigational complexity and may result in a long-term **moderate** adverse impact on navigation.

Under Alternative D2, the fishing industry–proposed transit lane intersects four contiguous BOEM lease areas: OCS-A 0486, OCS-A 0487, OCS-A 0500, and OCS-A 0501.[48] Under this alternative, the easternmost reach of the RWF Lease Area would be open for vessel traffic. If the selected alternatives for proposed wind energy projects in the OCS-A 0487, OCS-A 0500, and OCS-A 0501 lease areas to the south of this section were to adopt a similar transit alternative to allow north–south traffic, it would reduce the number of structures but may also increase navigational complexity by concentrating traffic in

[47] Note that OCS-A 0517 is part of the No Action Alternative.
[48] Note that OCS-A 0501 is part of the No Action Alternative.

the open area and increasing the likelihood that fishing activities will occur there. This could lead to conflicting uses and, accordingly, increased risk of allision/collision, resulting in a cumulative long-term to moderate adverse impact on navigation. If the other projects were to develop structures that preclude north–south transit, the cumulative impact on navigation would be long term **moderate** adverse.

Under Alternative D3, the setback proposed would intersect only the OCS-A 0486 Lease Area (RWF). Under this alternative, the lack of structures along the northwestern edge of the Lease Area would extend the traffic separation scheme buffer from 1 nm to 2 nm. No other RI/MA and MA WEA lease areas would be affected by this change, resulting in a long-term **moderate** adverse cumulative impact to navigation.

Combining alternatives would result in combined effects. It would reduce the number of structures but may also increase navigational complexity by concentrating traffic in the open area and increasing the likelihood that fishing activities will occur there. This could lead to conflicting uses and, accordingly, increased risk of allision/collision, Alternatives D1+D2, D1+D3, and D1+D2+D3 would result in long-term **moderate** adverse cumulative impacts.

For the Viewshed Alternative, structures removed by this alternative relative to the Proposed Action are positioned away from other lease areas and would not cause additional interactions with structures in those other areas. As a result, the cumulative impact of each of the Alternative E layouts would be long term **minor** adverse to navigation.

Under the Higher Capacity Turbine Alternative, presence of structures impacts from cumulative activities could be slightly reduced but similar to the Proposed Action (long term **moderate** adverse) depending on the alternative (C, D, or E) chosen and the location(s) of foundations affected by the reduction.

3.16.2.4.3 Conclusions

Although these alternatives would reduce the number of WTGs when compared to the maximum-case scenario under the Proposed Action and, in turn, the associated IACs and vessel activity, Alternatives C through F would maintain uniform north–south and east–west grid spacing and separation of 1 nm. Therefore, BOEM expects that the impacts resulting from each alternative alone would be similar to the Proposed Action: long term **moderate** adverse.

In the context of other future actions, BOEM expects the alternative's impacts would depend on development in nearby lease areas. Alternative C would add sources of navigation impacts (e.g., structures, noise, port utilization) to the No Action Alternative at quantities and durations similar to the Proposed Action. Therefore, the overall impact on navigation and vessel traffic when combined with past, present, and reasonably foreseeable activities would be the same as under the Proposed Action: long term intermittent **moderate** adverse.

Alternative D could reduce impacts to **minor** to **moderate** adverse if other lease areas likewise limit development to create an east–west area that is open to traffic. However, if the other lease areas were to develop fully, the impacts of each Alternative D scenario when combined with other future activities would be the same level as the Proposed Action: long term **moderate** adverse.

For Alternative E, the locations where structures would be eliminated would not interact with development in other lease areas. Therefore, BOEM expects Alternative E's impacts would be long term **minor** to **moderate** adverse.

For Alternative F, the locations where structures would be eliminated cannot be determined. Depending on those locations, the Project could or could not interact with development in other lease areas. Therefore, BOEM expects Alternative F's impacts would be similar to that of the Proposed Action (long term **moderate** adverse) depending on the alternative (C, D, or E) chosen.

3.16.2.5 Alternative G: Impacts of the Preferred Alternative on Navigation and Vessel Traffic

3.16.2.5.1 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Presence of structures: Alternative G would avoid placement of WTGs in the southwest section of the Lease Area as well as in numerous central locations. The avoidance of the southwest section could alleviate some navigational complexity around that area, though it would not have an impact on transiting vessels due to the presence of WTGs to the north of this area and the adjacent SFWF (OCS-A 0517). Alternative G would avoid an area used by some fishing vessels, as shown in Figure 3.16-3. The removal of WTGs in central locations would not affect transits but could affect vessels operating within the Lease Area. From a navigation and vessel traffic perspective, Alternatives G, G1, G2, and G3 would have similar impacts, slightly reduced from the Proposed Action: long term **minor** to **moderate** adverse.

3.16.2.5.2 Cumulative Impacts

Offshore Activities and Facilities

Presence of structures: Under Alternative G, impacts from the presence of structures could be slightly reduced but similar to the Proposed Action (long term **moderate** adverse) due to other wind lease areas south of the Lease Area. Although the removal of WTGs would open the southwest section of the Lease Area to vessels, the other lease areas would prevent vessels from transiting in that area.

3.16.2.5.3 Conclusions

Although Alternative G would reduce the number of WTGs when compared to the Proposed Action, it would maintain its uniform north–south and east–west grid spacing and separation of 1 nm. It would eliminate WTGs in the southwest section of the Lease Area, but that impact would be mitigated by the presence of the SFWF (OCS-A 0517). Therefore, BOEM expects that the impacts resulting from Alternative G would be slightly reduced from the Proposed Action: long term **minor** to **moderate** adverse.

In the context of other future actions, the presence of additional wind lease areas to the south would result in impacts similar to that of the Proposed Action: long term **moderate** adverse.

3.16.2.6 Mitigation

Mitigation measures resulting from agency consultations for navigation and vessel traffic are identified in Appendix F, Table F-2, and addressed in Table 3.16-5.

Table 3.16-5. Mitigation and Monitoring Measures Resulting from Consultations for Navigation and Vessel Traffic (Appendix F, Table F-2)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Submarine cable system burial plan	Revolution Wind shall submit a copy of the submarine cable system burial plan as part of their facility design report and fabrication and installation report that depicts precise planned locations and burial depths of the entire cable system.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.
Boulder relocation reporting	The locations of any boulder (which would protrude > 2 meters or more on the seafloor) relocated during cable installation activities must be reported to BOEM, USCG, NOAA, and the local harbormaster. These locations must be reported in latitude and longitude degrees to the nearest 10 thousandth of a decimal degree (roughly the nearest meter), or as precise as practicable.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.
Vessel safety practices	All Project vessels involved in construction, O&M, and decommissioning activities would comply with U.S. or international Safety of Life at Sea standards, as applicable, with regard to vessel construction, vessel safety equipment, and crewing practices.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.
WTG and OSS marking	Each WTG and OSS would be marked with private aids to navigation (PATONs), subject to the approval of the Commander (dpw-1), First Coast Guard District. Revolution Wind would do the following: Provide BOEM and USCG with a proposed lighting, marking, and signaling plan, which must be approved by BOEM after consultation with the USCG. The plan should conform to the International Association of Marine Aids to Navigation and Lighthouse Authorities Recommendation G1162, The Marking of Man-Made Offshore Structures. Should any part of the recommendation conflict with federal law or regulation, or if SFW seeks an alternative to the recommendation, Revolution Wind must consult with the USCG. Mark each individual WTG and OSS with clearly visible, unique, alphanumeric identification characters. Light each WTG and OSS in a manner that is visible by mariners in a 360-degree arc around the WTG and OSS. Apply to the First Coast Guard District to establish PATONs for the facility. Approval for all PATONs must be obtained before installation of the Revolution Wind structures begins.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	Ensure each WTG is lighted with red obstruction lighting consistent with the FAA Advisory Circular 70/7460-1L Change 2 (FAA 2018), so long as this requirement does not preclude the use of an ADLS. Provide signage that covers 360-degrees of the wind turbine structures warning vessels of the air draft of the turbine blades as determined at highest astronomical tide. Cooperate with USCG and NOAA to ensure that cable routes and wind turbines are depicted on appropriate government produced and commercially available nautical charts. Provide mariner information sheets on Revolution Wind's website with details on the location of the turbines and specifics such as blade clearance above sea level.	
WTG shut-down mechanism	Equip all WTG rotors (blade assemblies) with control mechanisms operable from the Revolution Wind control centers available 24 hours a day, 7 days a week. The control mechanisms shall enable control room operators to shut down the requested WTGs within an agreed upon time of notification between the USCG and Revolution Wind. A formal shut-down procedure would be part of the standard operating procedures and periodically tested. Normally, USCG-ordered shut downs would be limited to those WTGs in the immediate vicinity of an emergency and for as short a period as is safely practicable under the circumstances, as determined by the USCG.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.
USCG training and exercises	Revolution Wind would participate in periodic USCG-coordinated training and exercises to test and refine notification and shut-down procedures and to provide SAR training opportunities for USCG vessels and aircraft.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.
Operations and maintenance plan	Prior to operation of the Project, Revolution Wind shall submit a written plan for operations and maintenance, which includes control center(s), for review by BOEM and the USCG. The plan must demonstrate that the control center(s) would be adequately staffed to perform standard operating procedures, communications capabilities, and monitoring capabilities. The plan shall include the following topics, which may be modified through ongoing discussions with the USCG:	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	Standard operating procedures: Methods for establishing and testing WTG rotor shut-down; methods of lighting control; method(s) for notifying the USCG of mariners in distress or potential/actual SAR incidents; method(s) for notifying the USCG of any events or incidents that may impact maritime safety or security; and methods for providing the USCG with environmental data, imagery, communications and other information pertinent to SAR or marine pollution response. Staffing: Number of personnel intended to staff the control center(s) to ensure continuous monitoring of WTG operations, communications, and surveillance systems. Communications: Capabilities to be maintained by the control center(s) to communicate with the USCG and mariners within and in the vicinity of the Project area. Communications capability shall at a minimum include VHF marine radio and landline and wireless for voice and data. Monitoring: The control center(s) should maintain the capability to monitor the Project's installation and operations in real time (including night and periods of poor visibility) for determining the status of all PATONs, and to detect any survivor who has climbed to the survivor's platform, if installed, on any WTG or OSS.	
WTG/OSS installation	No WTG/OSS installation work will begin in the Lease Area (i.e., on or under the water) without prior review by BOEM and USCG of a plan submitted by Revolution Wind that describes the schedule and process for erecting each WTG, including all planned mitigations to be implemented to minimize any adverse impacts on navigation while installation is ongoing. Appropriate Notice to Mariners submissions would accompany the plan.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.
USCG reporting	Complaints: On a monthly basis during installation, Revolution Wind shall provide USCG with a description of any complaints received (either written or oral) by boaters, fishermen, commercial vessel operators, or other mariners regarding impacts on navigation safety allegedly caused by construction vessels, crew transfer vessels, barges, or other equipment. Describe any remedial action taken in response to complaints received.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	Correspondence: Revolution Wind shall provide to USCG copies of any correspondence received by Revolution Wind from other federal, state, or local agencies that mention or address navigation safety issues. Maintenance: Revolution Wind would provide the USCG with its planned WTG maintenance schedule, forecasted out to at least one quarter. Appropriate Notice to Mariners submissions would accompany each maintenance schedule.	
Public participation	To ensure sufficient opportunity for the public to receive information directly from the owners/operators of the wind energy facility, Revolution Wind would attend periodic meetings of the Southeastern Massachusetts and Rhode Island Port Safety and Security Forums to provide briefs on the status of construction and operations and on any problems or issues encountered with respect to navigation safety.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.
Helicopter landing platforms	If Revolution Wind's OSSs include helicopter-landing platforms, those platforms would be designed and built to accommodate up to and including USCG H-60-sized rescue helicopters.	This measure would not modify the impact determinations for navigation and vessel traffic but would ensure that these effects do not exceed the levels analyzed herein.

3.16.2.6.1 Measures Incorporated into the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.16-5 and in Appendix F, Table F-2, are incorporated into Alternative G (Preferred Alternative). These measures, if adopted, would further define how the effectiveness and enforcement of EPMs would be ensured and improve accountability for compliance with EPMs by requiring the submittal of plans for approval by the enforcing agency(ies) and by defining reporting requirements. Because these measures ensure the effectiveness of and compliance with EPMs that are already analyzed as part of the Proposed Action, implementation of these measures would not further reduce the impact level of the Proposed Action from what is described in Section 3.16.2. Agency-proposed measures related to vessel speed restrictions would expand upon Revolution Wind's EPMs to require that all vessels regardless of size would comply with speed restrictions in any seasonal management area, dynamic management area, or slow zone. Although adoption of these measures would reduce risk to marine mammals (see Section 3.15) and sea turtles (see Section 3.19) under the Proposed Action, it would not alter the impact determinations for navigation and vessel traffic.

3.17 Other Marine Uses

3.17.1 Description of the Affected Environment for Other Marine Uses

Geographic analysis area: The GAA for other marine uses: scientific research and surveys includes the footprint of the Proposed Action and all reasonably foreseeable projects between Maine and mid-North Carolina (Figure 3.17-1). This area encompasses locations where scientific research and surveys are anticipated.

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of GAAs for additional other marine uses categories analyzed in the EIS (aviation and air traffic, land-based radar, military and national security, and undersea cables).

3.17.1.1 Aviation and Air Traffic

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to aviation and air traffic from implementation of the Proposed Action and other considered alternatives.

3.17.1.2 Land-Based Radar

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to land-based radar from implementation of the Proposed Action and other considered alternatives.

3.17.1.3 Military and National Security

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to military and national security from implementation of the Proposed Action and other considered alternatives.

3.17.1.4 Scientific Research and Surveys

Affected environment: Government-managed fisheries surveys, both state and federal, occur within the region at varying times of year. As an example, through the Ecosystems Surveys Branch, NOAA Fisheries collects fishery-independent data using standardized research vessel surveys from Cape Hatteras, North Carolina, to the Scotian shelf. These data are used for assessment, management, and a variety of research programs (NOAA Fisheries 2018). NOAA Fisheries' seasonal survey locations vary and are randomly selected and stratified by depth. BOEM and NOAA have developed a federal survey mitigation strategy for the northeast U.S. region that addresses potential impacts of offshore wind energy development on NOAA Fisheries' scientific surveys (Hare et al. 2022). Because of the depths and acreage in the region, there is a likelihood of sample survey locations being placed within the RWF and waters along the RWEC. It is likely that other surveys conducted by academic institutions and non-governmental organizations occur within the region (VHB 2023).

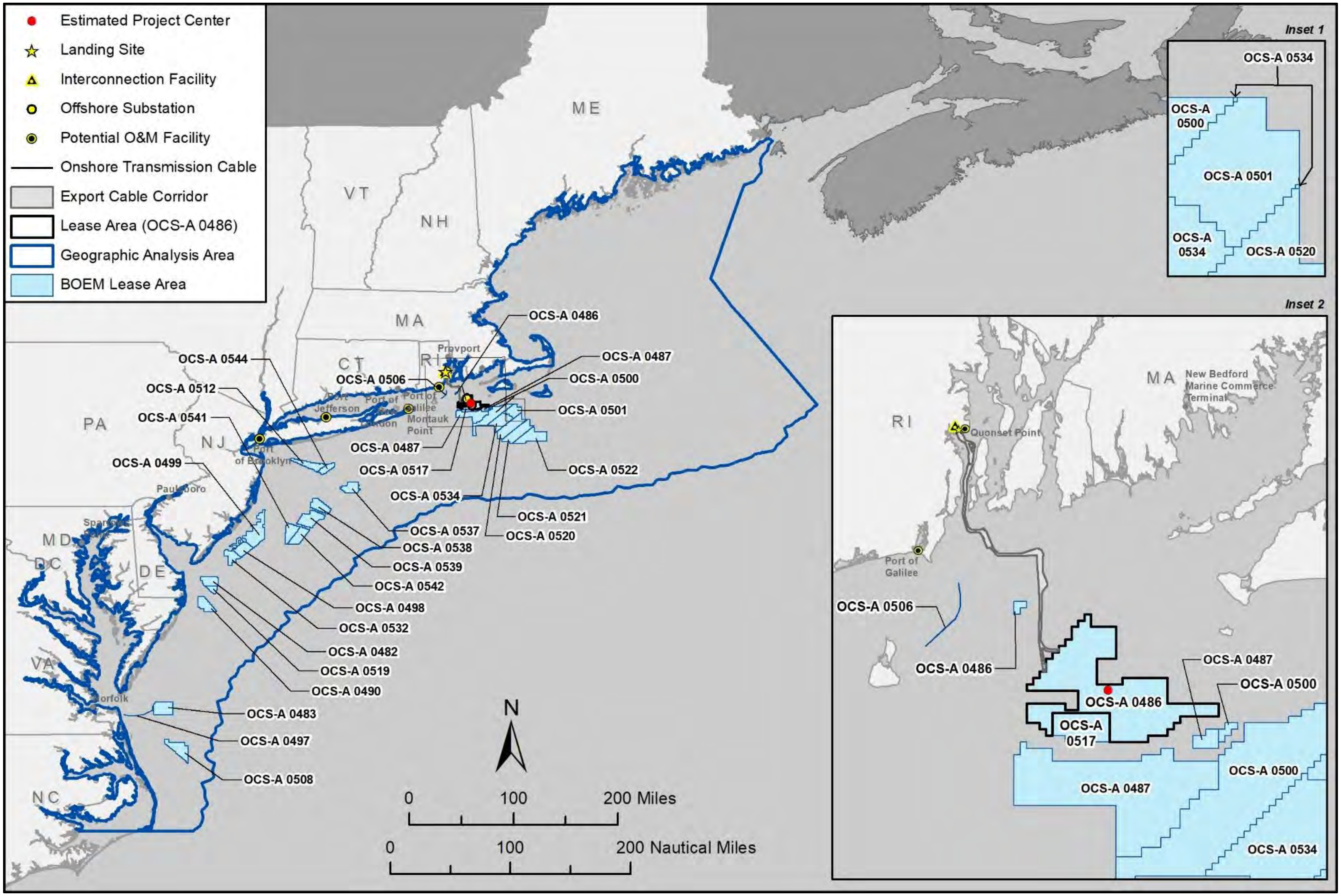

Figure 3.17-1. Geographic analysis areas for other marine uses: scientific research and surveys.

Regular fisheries management and ecosystem monitoring surveys conducted by or in coordination with the NEFSC would overlap offshore wind lease areas in the New England region and south into the mid-Atlantic region. Surveys include 1) the NEFSC Bottom Trawl Survey, a more than 50-year multispecies stock assessment tool using a bottom trawl; 2) the NEFSC Sea Scallop/Integrated Habitat Survey, a sea scallop stock assessment and habitat characterization tool using a bottom dredge and camera tow; 3) the NEFSC Surfclam/Ocean Quahog Survey, a stock assessment tool for both species using a bottom dredge; 4) the NEFSC Ecosystem Monitoring Program, a more than 40-year shelf ecosystem monitoring program using plankton tows and conductivity, temperature, and depth units; 5) NOAA's Atlantic Marine Assessment Program for Protected Species aerial and shipboard survey; and 6) North Atlantic Right Whale Sighting Advisory System aerial survey (BOEM 2021). As future wind development continues, alternative platforms, sampling designs, and sampling methodologies would be needed to maintain surveys conducted in or near the Project.

3.17.1.5 Undersea Cables

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to undersea cables from implementation of the Proposed Action and other considered alternatives.

3.17.2 Environmental Consequences

3.17.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

The analysis presented in this section considers the impacts resulting from the maximum design scenario under the PDE approach developed by BOEM to support offshore wind project development (Rowe et al. 2017). The maximum design size specifications defined in Appendix D, Table D-1, are PDE parameters used to conduct this analysis.

The following design parameters would result in different impacts relative to those generated by the design elements considered under the PDE:

- The selection of lower capacity WTG designs would reduce the total WTG height from 873 to as low as 648 feet, reducing impacts to low-flying aircraft.
- The selection of a higher capacity WTG design would reduce the total number of fixed structures that survey vessels could be required to avoid.

See Appendix E1 for a summary of IPFs analyzed for other marine uses across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have a negligible adverse effect are excluded from Chapter 3 and provided in Appendix E1, Tables E2-15 to E2-21. Other marine uses subsections that are determined by BOEM to have a minor or less adverse effect from the action alternatives (aviation and air traffic, military uses, land-based radar, and undersea cables) are provided in Appendix E2.

Table 3.17-1 provides a summary of IPF findings carried forward for analysis in this section. Each alternative analysis discussion consists of the construction and installation phase, the O&M phase, the decommissioning phase, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion. This comparison considers the implementation of all EPMs proposed by Revolution Wind to avoid and minimize adverse impacts on other marine uses. These EPMs are summarized in Appendix F, Table F-1.

A detailed analysis of the Proposed Action follows Table 3.17-1. Detailed analysis of other considered action alternatives is also provided below the table if analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component. Where feasible, calculations for specific alternative impacts are provided in Appendix E4 to facilitate reader comparison across alternatives.

The conclusion section within each alternative analysis discussion includes rationale for the effects determinations. The overall effect determination for each alternative is **major** adverse for scientific research and surveys.

Table 3.17-1. Alternative Comparison Summary for Other Marine Uses

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative G (Preferred Alternative)	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
Scientific Research and Surveys							
Anchoring and new cable emplacement/ maintenance	**Offshore: O**ffshore energy facility construction of new cable emplacement and maintenance of cables would involve increased vessel traffic, which could impact scientific research and surveys by increasing the number of vessels, increasing navigational complexity and risk of collisions. However, these impacts are expected to be limited because cable emplacement vessels would be restricted to emplacement corridors and their activities would be of short duration. Therefore, the effects of anchoring and new cable emplacement and maintenance on scientific research and surveys would be **negligible** adverse.	**Offshore:** Vessel anchoring, cable installation, seafloor preparation, and placement of cable protection activities would occur during Project construction and O&M that could impact scientific research and survey uses. Impacts are expected to be limited because cable emplacement vessels would be restricted to emplacement corridors, and their activities would be of short duration. Therefore, the effects of anchoring and new cable emplacement and maintenance under the Proposed Action on scientific research and studies would be **negligible** adverse. Reasonably foreseeable future actions in combination with the Proposed Action could result in up to 11,631 acres that could be affected by anchoring and mooring and up to 105,390 acres for cable installation activities during offshore wind energy development within the GAA. Therefore, the Proposed Action when combined with past, present, and other reasonably foreseeable project impacts would result in **minor** adverse impacts on scientific research and survey.	**Offshore:** all offshore impacts under Alternatives C through F would result in a noticeably smaller offshore impact compared to the maximum case under the Proposed Action. The effects of this IPF would therefore be the same or slightly reduced relative to those described for the Proposed Action: **negligible** adverse for construction and O&M and **minor** adverse for cumulative.				Offshore: All offshore impacts under Alternatives G would result in a noticeably smaller offshore footprint and reduced IAC cable length compared to the maximum case under the Proposed Action. The estimated construction impact footprint for this IPF is 4,291 acres under Alternative G and 3,803 to 3,812 acres under Alternatives G1 through G3. The effects of this IPF would therefore be similar to the Proposed Action but reduced in extent: **negligible** adverse for construction and O&M and **minor** adverse for cumulative.
Light	**Offshore:** Future offshore wind activities without the Proposed Action would result in an increase in permanent aviation warning lighting on WTGs offshore. The increase in light in the area could change conditions or species' behavior, which could impact the results of scientific research and surveys. Therefore, impacts from structural lighting alone on scientific research and surveys under the No Action Alternative would be **minor** adverse.	**Offshore:** Construction and installation and O&M of the Proposed Action would result in an increase in lighting on WTGs offshore, which could have minor adverse effects on scientific research and surveys by impacting the natural environment and changing conditions compared to other areas used for scientific research and surveys that do not have artificial light. The increase in light in the area could change species' behavior, which could impact the results of scientific research and surveys. Therefore, impacts from structural lighting alone on scientific research and surveys under the No Action Alternative would be **minor** adverse.	**Offshore:** While Alternatives C through F could result in a reduction in construction and operational lighting, the effects of this IPF on scientific research and surveys would otherwise be similar to those described for the Proposed Action. Therefore, the impact on scientific research and surveys under this alternative would be **minor** adverse.				Offshore: Although Alternatives G would result in a reduction in construction and operational lighting, the effects of this IPF on scientific research and surveys would otherwise be similar to the Proposed Action. Therefore, the impact on scientific research and surveys under this alternative would be **minor** adverse.
Presence of structures	**Offshore:** Offshore wind facilities could adversely affect scientific surveys by preclusion of NOAA survey vessels and aircraft from sampling in survey strata and impacts on the random-stratified	**Offshore:** NMFS scientific research and protected species surveys could be curtailed within the Lease Area due to Project activities, and NMFS believes that construction of the RWF and the	**Offshore:** While the offshore footprint would be reduced under all configurations, the effects of this IPF on scientific research and surveys under Alternatives C through F would otherwise be similar to those described for the Proposed Action. Therefore, the impact of this IPF on scientific research and surveys would be **major** adverse.				Offshore: Although the offshore footprint would be reduced under Alternative G (e.g., the maximum construction disturbance footprint is estimated at 583 acres for Alternative G and 482 acres for Alternatives G1

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) Up to 100 WTGs	Alternative C (Habitat Alternative) 64 or 65 WTGs	Alternative G (Preferred Alternative)	Alternative E (Viewshed Alternative) 64 or 81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative)
	statistical design that is the basis for assessments, advice, and analyses. Scientific survey and protected species survey operations would therefore be reduced or eliminated as offshore wind facilities are constructed (BOEM 2021). Overall, the No Action Alternative would have **major** adverse effects on NMFS' scientific research and protected species surveys, potentially leading to impacts on fishery participants and communities, as well as potential **major** adverse impacts on monitoring and assessment activities associated with recovery and conservation programs for protected species.	survey adjustments needed would constitute a long-term **major** adverse impact on those surveys.					through G3), the effects of this IPF on scientific research and surveys would otherwise be similar to the Proposed Action. Therefore, the impact of this IPF on scientific research and surveys would be **major** adverse.
Vessel traffic	**Offshore:** Increased vessel traffic due to future offshore wind facilities could lead to course changes of scientific and research vessels, congestion and delays at ports, and increased traffic along vessel transit routes. Therefore, the effects of vessel traffic on scientific and research surveys under the No Action Alternative would be **minor** adverse.	**Offshore:** Increased vessel traffic due to construction and installation and O&M of the Proposed Action could lead to course changes of scientific and research vessels and increased traffic along vessel transit routes. Additionally, offshore construction activities of Project facilities could be a hazard to scientific research vessels as they could experience hazards from passing Project construction vessels. With EPMs, however, the Proposed Action would be **minor** adverse for vessel traffic. Vessel activity could peak with as many as 262 vessels involved in construction of reasonably foreseeable projects. Therefore, the cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would be **minor** adverse.	**Offshore:** Vessel traffic associated with Alternatives C through F may result in slightly reduced vessel traffic in the Lease Area and around ports given the smaller offshore footprint. While the offshore footprint would be reduced under all configurations, vessel traffic is expected to remain at similar levels as vessel traffic under the Proposed Project. Reduced navigational complexity combined with a smaller construction footprint and fewer offshore structures would result in the effects of this IPF being the same or slightly reduced relative to those described for the Proposed Action. Therefore, impacts on scientific research and surveys would be **minor** adverse under all Project phases.				Offshore: Vessel traffic associated with Alternatives G may be slightly reduced in the Lease Area and around ports, given the smaller offshore footprint. Although the offshore footprint and IAC cable length would be reduced, vessel traffic is expected to remain at similar levels as vessel traffic under the Proposed Action. Reduced navigational complexity combined with a smaller construction footprint and fewer offshore structures would result in the effects of this IPF being the same or slightly reduced relative to the Proposed Action. Therefore, impacts on scientific research and surveys would be **minor** adverse under all Project phases.

3.17.2.2 Alternative A: Impacts of the No Action Alternative on Aviation and Air Traffic

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to aviation and air traffic control from implementation of the No Action Alternative.

3.17.2.3 Alternative A: Impacts of the No Action Alternative on Land-Based Radar

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to aviation and air traffic control from implementation of the No Action Alternative.

3.17.2.4 Alternative A: Impacts of the No Action Alternative on Military and National Security (including Search and Rescue)

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to aviation and air traffic control from implementation of the No Action Alternative.

3.17.2.5 Alternative A: Impacts of the No Action Alternative on Scientific Research and Surveys

3.17.2.5.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for scientific research and surveys (see Section 3.17.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the GAA. These IPFs are described and analyzed in Appendix E1.

3.17.2.5.2 Cumulative Impacts

This section discloses potential scientific research and surveys impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

Anchoring and new cable emplacement/maintenance: Up to 8,427 acres could be affected by anchoring/mooring activities and up to acres of 101,381 acres of cable installation during offshore wind energy development within the GAA. This offshore energy facility construction of new cable emplacement and maintenance of cables would involve increased vessel traffic, which could impact scientific research and surveys by increasing the number of vessels within the GAA. Increased vessel traffic due to anchoring and cable maintenance of wind facilities could lead to course changes of scientific research vessels, thereby increasing navigational complexity and risk of collisions. These impacts are expected to be the highest during construction phases and lower during infrequent yearly routine maintenance and monitoring of offshore wind activities. Therefore, the effects of anchoring and new cable emplacement and maintenance under the No Action Alternative on scientific research and surveys would be **negligible** adverse.

Light: Future offshore wind activities without the Proposed Action would result in an increase in permanent aviation warning lighting on WTGs offshore. All existing stationary structures would have navigation marking and lighting in accordance with FAA, USCG, and BOEM guidance to minimize allision risks. Implementation of navigational lighting and marking per FAA and BOEM requirements and guidelines would further reduce the risk of scientific research vessel collisions. This would result in a general increase of lights in the GAA, which could impact the natural environment and alter research conditions compared to other areas used for scientific research and surveys that do not have artificial light. The increase in light in the area could change species' behavior, which could impact the results of scientific research and surveys. Therefore, impacts from structural lighting alone on scientific research and surveys under the No Action Alternative would be **minor** adverse.

Presence of structures: This EIS incorporates, by reference, the detailed analysis of potential impacts to scientific research and surveys provided in the Vineyard Wind final EIS (BOEM 2021). Activities associated with offshore wind development such as site assessment activities, construction of reasonably foreseeable offshore wind farms (including placement of structures such as OSSs and WTGs), associated cable systems, and vessel activity would present additional navigational obstructions for sea and air-based scientific surveys. If construction of all projected future offshore wind facilities occurs along the Atlantic coast, these developments would add up to as many as 3,088 structures between by 2030. Collectively, these developments would prevent NMFS from continuing ongoing scientific research surveys or protected species surveys under current vessel capacities and could reduce future opportunities for NMFS' scientific research 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 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.

In summary, offshore wind facilities could adversely affect scientific surveys by preclusion of NOAA survey vessels and aircraft from sampling in survey strata and impacts on the random-stratified statistical design that is the basis for assessments, advice, and analyses. Scientific survey and protected species survey operations would therefore be reduced or eliminated as offshore wind facilities are constructed (BOEM 2021). Offshore wind facilities would disrupt survey sampling statistical designs, such as random stratified sampling. Impacts to the statistical design of region-wide surveys violate the assumptions of probabilistic sampling methods. Development of new survey technologies, changes in survey methodologies, and required calibrations could help to mitigate losses in accuracy and precision of current practices due to the impacts of wind development on survey strata.

Other offshore wind projects could also require implementation of mitigation and monitoring measures through BOEM approvals or consultations. Identification and analysis of specific measures are speculative at this time; however, these measures could further impact NMFS's ongoing scientific research surveys or protected species surveys because of the increased vessel activity and/or in-water structures from these other projects.

BOEM and NOAA have developed a federal survey mitigation strategy for Vineyard Wind that is currently undergoing public review and that addresses potential impacts of offshore wind energy development on NOAA Fisheries' scientific surveys (Hare et al. 2022).

Overall, the No Action Alternative would have **major** adverse effects on NMFS' scientific research and protected species surveys, potentially leading to impacts on fishery participants and communities, as well as potential **major** adverse impacts on monitoring and assessment activities associated with recovery and conservation programs for protected species. Therefore, the effects of the presence of structures on scientific research and surveys under the No Action Alternative would be **major** adverse.

<u>Vessel traffic:</u> Although no future non–offshore wind stationary structures were identified within the Lease Area, increased vessel traffic due to future offshore wind facilities located outside of the Lease Area could lead to course changes of scientific and research vessels, congestion and delays at ports, and increased traffic along vessel transit routes. Vessel activity could peak in 2025 with as many as 210 vessels involved in construction of reasonably foreseeable OSW projects. While construction periods of various wind energy facilities may be staggered, some overlap would result in a cumulative impact to traffic loads. Therefore, the effects of vessel traffic on scientific and research surveys under the No Action Alternative would be **minor** adverse.

3.17.2.5.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on other marine uses associated with the Project would not occur. However, ongoing and future activities would have **major** adverse impacts on scientific research and surveys due to the presence of structures that reduce future opportunities for NMFS' scientific research in the area.

BOEM anticipates **moderate** adverse impacts on scientific research and surveys due to the impacts of ongoing offshore wind activities (BIWF). BOEM anticipates that the impacts to reasonably foreseeable offshore wind activities would be **major** adverse, primarily because of the potential impacts of structures to NMFS survey efforts. The No Action Alternative would forgo the fisheries and benthic habitat monitoring that Revolution 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.

Considering all the IPFs together, BOEM anticipates that the impacts associated with future offshore wind activities in the GAA combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore would result in **major** adverse impacts for scientific research and surveys and USCG SAR activities (of people or marine mammals). The presence of stationary structures could prevent or hamper continued NMFS scientific research surveys using current vessel capacities and monitoring protocols or reduce opportunities for other NMFS scientific research surveys in the area. Coordinators of large vessel survey operations or operations deploying mobile survey gear have determined that activities within offshore wind facilities would not be within current safety and operational limits. In addition, changes in required flight altitudes due to the proposed WTG height would affect aerial survey design and protocols. BOEM acknowledges that NOAA's Office of Marine and Aviation Operations endorses the restriction of large vessel operations to greater than 1 nm from wind installations due to safety and operational challenges.

3.17.2.6 Alternative A: Impacts of the No Action Alternative on Undersea Cables

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to aviation and air traffic control from implementation of the No Action Alternative.

3.17.2.7 Alternative B: Impacts of the Proposed Action on Aviation and Air Traffic

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to aviation and air traffic control from implementation of the Proposed Action and other considered alternatives.

3.17.2.8 Alternative B: Impacts of the Proposed Action on Land-Based Radar

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to land-based radar from implementation of the Proposed Action and other considered alternatives.

3.17.2.9 Alternative B: Impacts of the Proposed Action on Military and National Security (including Search and Rescue)

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to military and national security from implementation of the Proposed Action and other considered alternatives.

3.17.2.10 Alternative B: Impacts of the Proposed Action on Scientific Research and Surveys

3.17.2.10.1 Construction and Installation

Offshore Activities and Facilities

Anchoring and new cable emplacement/maintenance: Vessel anchoring, cable installation, seafloor preparation, and placement of cable protection activities would occur during Project construction. This would involve increased construction vessel traffic that could impact scientific research and survey uses by increasing the number of vessels within the GAA. Additionally, cable emplacement could impact bottom-trawl NMFS surveys that are planned in wind areas, although it is likelier that the development of the RWF would preclude scientific research and studies from occurring in the GAA, which would result in a greater impact discussed under Presence of Structures. Impacts specific to anchoring and cable emplacement during Project construction would be restricted to cable emplacement corridors, which would result in limited contact with cable emplacement installation vessels. Therefore, the effects of anchoring and new cable emplacement and maintenance under the Proposed Action on scientific research and studies would be **negligible** adverse.

Light: Construction and installation of the Proposed Action would result in an increase in temporary construction lighting on WTGs offshore. All existing stationary structures would have navigation marking and lighting in accordance with FAA, USCG, and BOEM guidance to minimize collision risks. This would result in a general increase of lights in the GAA, which could have minor adverse effects on scientific research and surveys by impacting the natural environment and changing conditions compared to other areas used for scientific research and surveys that do not have artificial light. The increase in light in the area could change species' behavior, which could impact the results of scientific research and surveys. Therefore, impacts from structural lighting alone on scientific research and surveys under the No Action would be **minor** adverse.

Presence of structures and vessel traffic: Scientific research and protected species surveys could be affected from the construction of the RWF and RWEC. Some vessels or low-flying aircraft could be required to alter course to avoid WTGs. During review of other wind energy proposals, BOEM found that that NOAA Fisheries experienced reduced sampling productivity because of impacts associated with the presence of wind energy structures (Hare et al. 2022). NOAA has concluded that, within offshore wind facility areas, survey operations would be curtailed, if not eliminated, under current vessel capacities and monitoring protocols. Specifically, coordinators of large vessel survey operations or operations deploying mobile survey gear have currently determined that activities within offshore wind facilities are not within their safety and operational limits. Vessels could be required to make minor course adjustments to avoid collisions but would not be completely blocked from using the areas around the WTGs. Nevertheless, NMFS scientific research and protected species surveys could be curtailed within the Lease Area, and NMFS believes that construction of the RWF and the survey adjustments needed would constitute a long-term **major** adverse impact on those surveys.

Increased vessel traffic due to construction and installation of the Proposed Action could lead to course changes of scientific and research vessels and increased traffic along vessel transit routes. Additionally, offshore construction activities of Project facilities could be a hazard to scientific research vessels as they could experience hazards from passing Project construction vessels. Two primary means of reducing this risk are updates to mariners from the Project and safety zones around construction activity. Revolution Wind has committed to informing fishermen and other mariners about offshore activities related to the RWF. Fisheries liaisons and a team of fisheries representatives are based in regional ports, and updates would be provided to mariners online and via twice-daily updates on very high frequency channels. Safety zones can also protect mariners from potential hazards during construction activities. It is anticipated that the Coast Guard would implement safety zones during construction of the Project, as they did for the construction of the BIWF (USCG 2016). To reduce the likelihood of allision or collision during construction, Project safety vessel(s) would be on scene to advise mariners of construction activity (DNV GL Energy USA, Inc. 2020).

Because NMFS surveys could be curtailed in the Lease Area and because of increased collision risk, the effects of presence of structures and vessel traffic on scientific and research surveys under the Proposed Action would be **major** adverse for presence of structures and **minor** adverse for vessel traffic**.**

3.17.2.10.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

<u>Anchoring and new cable emplacement/maintenance:</u> Vessel anchoring and cable maintenance would occur during Project O&M and decommissioning. This would involve a slight increase in construction vessel traffic that could impact scientific research and survey uses by increasing the number of vessels within the GAA. Impacts specific to anchoring and cable emplacement during Project O&M and decommissioning are expected to be restricted to cable emplacement corridors, which would result in limited contact with cable emplacement and maintenance vessels. Cables associated with the RWF would be removed as part of decommissioning. Therefore, the effects of anchoring and new cable emplacement and maintenance under the Proposed Action on scientific research and studies would be **negligible** adverse.

<u>Light:</u> O&M and decommissioning of the Proposed Action would result in an increase in permanent lighting on up to 100 WTGs offshore. All existing stationary structures would have navigation marking and lighting in accordance with FAA, USCG, and BOEM guidance to minimize collision risks. Implementation of navigational lighting and marking per USCG and BOEM requirements and guidelines would further reduce the risk of scientific vessel collisions. This would result in a general increase of lights in the GAA, which could have a negative impact on scientific research and surveys by impacting the natural environment and changing conditions compared to other areas used for scientific research and surveys that do not have artificial light. The increase in light in the area could change species' behavior, which could impact the results of scientific research and surveys. Light impacts are expected to be **minor** adverse compared with other impacts discussed below in Presence of structures and vessel traffic. Lighting would be removed as part of WTG and OSS decommissioning. Therefore, impacts from structural lighting alone on scientific research and surveys under the Proposed Action would be **minor** adverse.

<u>Presence of structures and vessel traffic:</u> Scientific research and protected species surveys could be affected from the O&M and decommissioning of the RWF and RWEC. Some vessels or low-flying aircraft could be required to alter course to avoid WTGs. During review of other wind energy proposals, BOEM found that that NOAA Fisheries experienced reduced sampling productivity because of impacts associated with the presence of wind energy structures (Hare et al. 2022). NOAA has concluded that,

within offshore wind facility areas, survey operations would be curtailed, if not eliminated, under current vessel capacities and monitoring protocols. Specifically, coordinators of large vessel survey operations or operations deploying mobile survey gear have currently determined that activities within offshore wind facilities are not within their safety and operational limits. Vessels could be required to make minor course adjustments to avoid collisions but would not be completely blocked from using the areas around the WTGs. Nevertheless, NMFS scientific research and protected species surveys could be curtailed within the Lease Area, and NMFS believes that construction of the RWF and the survey adjustments needed would constitute a long-term **major** adverse impact on those surveys.

Increased vessel traffic due to O&M and decommissioning of the Proposed Action could lead to course changes of scientific and research vessels and increased traffic along vessel transit routes. However, less vessel traffic is anticipated during O&M and decommissioning than during construction and installation activities. Additionally, during operations, each WTG foundation would serve as an aid to navigation (ATON) for mariners as they are large structures that would be lighted and marked as required by applicable law and regulation, and as included in any/all conditions the Coast Guard may impose in conjunction with its private aids to navigation (PATON) permits. The Project structures and seaward components would be clearly marked on applicable NOAA nautical charts, including Chart No. 13218 (NOAA 2020). Revolution Wind would work closely with the USCG and NOAA to chart all elements of the Project (DNV GL Energy USA, Inc. 2020; Orsted 2020).

Therefore, the effects of presence of structures and vessel traffic on scientific and research surveys under the Proposed Action for O&M and decommissioning would be **major** adverse for presence of structures and **minor** adverse for vessel traffic.

3.17.2.10.3 Cumulative Impacts

Offshore Activities and Facilities

<u>Anchoring and new cable emplacement/maintenance:</u> Up to 11,631 acres could be affected by anchoring/mooring activities and up to 105,390 acres could be affected by cable installation during construction and installation of offshore elements of the RWF, combined with other reasonably foreseeable future actions. Construction of offshore elements of the RWF would involve cable emplacement, which would involve increased vessel traffic. This could create conflicts with scientific and research vessels by increasing the number of vessels within the GAA and the number of cables constructed. However, the cable emplacement vessels would be restricted to cable emplacement corridors, which would result in limited contact with scientific and research vessels. Therefore, the Proposed Action when combined with past, present, and other reasonably foreseeable project impacts would result in **minor** adverse impacts on scientific research and surveys.

<u>Light:</u> The Proposed Action would result in an increase in temporary lighting and permanent aviation warning lighting on WTGs offshore. All existing stationary structures would have navigation marking and lighting in accordance with FAA, USCG, and BOEM guidance to minimize collision risks. Implementation of navigational lighting and marking per USCG and BOEM requirements and guidelines would further reduce the risk of scientific vessel collisions. This would result in a general increase of lights in the GAA, which could have an impact on scientific and research surveys by increasing navigational complexity. Reasonably foreseeable activities combined with the Proposed Action would also increase lighting in the area and would include up to 3,190 additional lighted structures in the GAA.

Therefore, the cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would be **minor** adverse.

Presence of structures: This EIS incorporates by reference the detailed analysis of potential impacts to scientific research and surveys provided in the Vineyard Wind final EIS (BOEM 2021). In response to the impacts to scientific surveys identified in the Vineyard Wind final EIS, BOEM and NOAA developed a federal survey mitigation strategy for offshore wind energy development in the northeast region (see Section 3.17.2.22 and Table F-2, Appendix F).

Without this mitigation, the Proposed Action would result in long-term **major** adverse impacts to scientific research and surveys through the installation of up to 100 WTGs and two OSSs. The Proposed Action structures represent a 3% increase over the total estimated 3,088 WTG and OSS foundations under the No Action Alternative that could be present along the Atlantic coast if all projected future offshore wind facilities are constructed. Within the GAA, BOEM estimates a cumulative total of 3,190 offshore WTG and OSS foundations for the Proposed Action plus all other future offshore wind projects. These structures would result in adverse impacts to NMFS' scientific research and protected species surveys due to 1) WTG blade tip height that would exceed the survey altitude for current surveying methodologies, and 2) Lease Area geographic overlap with ongoing NMFS' Northeast Fisheries Science Center fishery resource monitoring surveys. Research and monitoring proposed by the lessees and/or conducted by other scientific institutions would continue in offshore wind facilities. Therefore, the cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would consist predominately of impacts described under the No Action Alternative, which would represent a long-term **major** adverse impact on NMFS's scientific research and protected species surveys and the resulting stock assessments.

Vessel traffic: The Proposed Action would result in increased vessel traffic due to construction and installation, O&M, and decommissioning of the Proposed Action that could lead to course changes of scientific and research vessels and increased traffic along vessel transit routes. Additionally, increased vessel traffic due to reasonably foreseeable future actions could lead to course changes of scientific and research vessels, congestion and delays at ports, and increased traffic along vessel transit routes. Vessel activity could peak with as many as 262 vessels involved in construction of reasonably foreseeable projects. While construction periods of various wind energy facilities could be staggered, some overlap would result in a cumulative impact to traffic loads. Therefore, the cumulative impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would be **minor** adverse.

3.17.2.10.4 Conclusions

Project construction and installation, O&M, and decommissioning would affect ongoing scientific research studies occurring in the GAA. Similar impacts from Project O&M would occur, although at a lesser extent and duration for some uses. BOEM anticipates that the impacts resulting from the Proposed Action alone would range from **negligible** to **major** adverse. Therefore, BOEM expects that the overall impact on scientific research and surveys from the Proposed Action alone to be **major** adverse.

In the context of other reasonably foreseeable environmental trends and planned actions, the impacts under the Proposed Action resulting from individual IPFs would range from **negligible** to **major** adverse. Considering all the IPFs together, BOEM anticipates that the overall impacts associated with the

Proposed Action when combined with past, present, and reasonably foreseeable activities would be **major** adverse for scientific research and surveys.

3.17.2.11 Alternative B: Impacts of the Proposed Action on Undersea Cables

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to undersea cables from implementation of the Proposed Action and other considered alternatives.

3.17.2.12 Alternatives C, D, E, and F: Aviation and Air Traffic

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to aviation and air traffic control from implementation of the Proposed Action and other considered alternatives.

3.17.2.13 Alternatives C, D, E, and F: Land-Based Radar

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to land-based radar from implementation of the Proposed Action and other considered alternatives.

3.17.2.14 Alternatives C, D, E, and F: Military and National Security (including Search and Rescue)

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to military and national security from implementation of the Proposed Action and other considered alternatives.

3.17.2.15 Alternatives C, D, E, and F: Scientific Research and Surveys

Table 3.17-1 provides a summary of IPF findings by alternative.

3.17.2.15.1 Conclusions

Although Alternatives C through F would reduce the number of WTGs and their associated inter-array cables, which would have an associated reduction in associated vessel traffic, BOEM expects that the impacts resulting from each alternative alone would be the same as the Proposed Action: **major** adverse. The overall impacts of Alternatives C through F when combined with past, present, and reasonably foreseeable activities would therefore be the same as under the Proposed Action: **major** adverse for scientific research and protected species surveys.

3.17.2.16 Alternatives C, D, E, and F: Undersea Cables

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to undersea cables from implementation of the Proposed Action and other considered alternatives.

3.17.2.17 Alternative G: Impacts of the Preferred Alternative on Aviation and Air Traffic

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to aviation and air traffic control from implementation of the Proposed Action and other considered alternatives.

3.17.2.18 Alternative G: Impacts of the Preferred Alternative on Land-Based Radar

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to land-based radar from implementation of the Proposed Action and other considered alternatives.

3.17.2.19 Alternative G: Impacts of the Preferred Alternative on Military and National Security (including Search and Rescue)

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to military and national security from implementation of the Proposed Action and other considered alternatives.

3.17.2.20 Alternative G: Impacts of the Preferred Alternative on Scientific Research and Surveys

Table 3.17-1 provides a summary of IPF findings for this alternative.

3.17.2.20.1 Conclusions

The construction and installation, O&M, and decommissioning of Alternative G would affect ongoing scientific research studies occurring in the GAA through the same mechanisms described for the Proposed Action, including increased vessel activity, presence of structures, light, and anchoring and cable emplacement. Although the overall extent of impacts to scientific research and surveys would be reduced under Alternative G relative to the Proposed Action, the significance of those effects would be the same. Therefore, the impacts of Alternative G alone on scientific research and surveys would be **major** adverse. Considering all IPFs together, BOEM anticipates that the overall impacts associated with Alternative G when combined with past, present, and reasonably foreseeable activities would be **major** adverse for scientific research and surveys.

3.17.2.21 Alternative G: Impacts of the Preferred Alternative on Undersea Cables

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to undersea cables from implementation of the Proposed Action and other considered alternatives.

3.17.2.22 Mitigation

Mitigation measures resulting from agency consultations for other marine uses (scientific research and surveys) are identified in Appendix F, Table F-2, and addressed in Table 3.17-2. Additional mitigation measures identified by BOEM and cooperating agencies are described in detail in Appendix F, Table F-3, and addressed in Table 3.17-3. If one or more of the measures analyzed below are adopted by BOEM and/or cooperating agencies, some adverse impacts could be further reduced.

Table 3.17-2. Mitigation and Monitoring Measures Resulting from Consultations for Other Marine Uses (scientific research and surveys) (Appendix F, Table F-2)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
WTG shutdown mechanism	Equip all WTG rotors (blade assemblies) with control mechanisms operable from the RWF control centers available 24 hours a day, 7 days a week. The control mechanisms shall enable control room operators to shut down the requested WTGs within an agreed-upon time of notification between the USCG and Revolution Wind. A formal shutdown procedure would be part of the standard operating procedures and periodically tested. Normally, USCG-ordered shutdowns would be limited to those WTGs in the immediate vicinity of an emergency and for as short a period as is safely practicable under the circumstances, as determined by the USCG.	This measure would not alter the impact determination for military and national security activities but would ensure that effects of project operations to SAR, pollution events, and other emergency response activities would be limited to levels considered herein.
USCG training and exercises	Revolution Wind would participate in periodic USCG-coordinated training and exercises to test and refine notification and shutdown procedures and to provide SAR training opportunities for USCG vessels and aircraft.	This measure would not alter the impact determination for military and national security activities but would ensure that effects of project operations to SAR, pollution events, and other emergency response activities would be limited to levels considered herein.
Operations and maintenance plan	Before the project becomes operational, Revolution Wind shall submit a written plan for O&M, which includes control center(s), for review by BOEM and the USCG. The plan must demonstrate that the control center(s) would be adequately staffed to perform standard operating procedures, communications capabilities, and monitoring capabilities necessary to support USCG activities. The plan shall include, but not be limited to, the following topics, which may be modified through ongoing discussions with the USCG: Standard operating procedures: Methods for establishing and testing WTG rotor shutdown; methods of lighting control; method(s) for notifying the USCG of mariners in distress or potential/actual SAR incidents; method(s) for notifying the USCG of any events or incidents that may impact maritime safety or	This measure would not alter the impact determination for military and national security activities but would ensure that effects of project operations to SAR, pollution events, and other emergency response activities would be limited to levels considered herein.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	security; and methods for providing the USCG with environmental data, imagery, communications, and other information pertinent to SAR or marine pollution response. Staffing: Number of personnel intended to staff the control center(s) to ensure continuous monitoring of WTG operations, communications, and surveillance systems. Communications: Capabilities to be maintained by the control center(s) to communicate with the USCG and mariners within and near the Lease Area. Communications capability shall at a minimum include very high frequency (VHF) marine radio and landline and wireless for voice and data. Monitoring: The control center(s) should maintain the capability to monitor RWF installation and operations in real time (including night and periods of poor visibility) for determining the status of all PATONs and detection of a survivor who has climbed to the survivor's platform, if installed, on any WTG or OSS.	
Helicopter landing platforms	If Revolution Wind's OSSs include helicopter landing platforms, those platforms would be designed and built to accommodate up to and including USCG H-60-sized rescue helicopters.	This measure would not alter the impact determination for military and national security activities but would ensure that effects of project operations to SAR, pollution events, and other emergency response activities would be limited to levels considered herein.
Fiber-optic sensing technology	Distributed fiber-optic sensing technology proposed for the Project or associated transmission cables would be reviewed by the DOD to ensure that distributed fiber-optic sensing is not used to detect sensitive data from DOD activities, to conduct any other type of surveillance of U.S. Government operations, or to otherwise pose a threat to national security.	This measure would not alter the impact determination for military and national security but would ensure that these impacts remain negligible.
NOAA Fisheries scientific surveys	The project should be required to mitigate the major impacts to NOAA Fisheries scientific surveys consistent with NMFS-BOEM Federal Survey Mitigation Strategy - Northeast U.S. Region. Revolution Wind's plans to mitigate these impacts at the project and regional levels should be provided to NMFS for review and	This measure would not alter the impact determination for scientific research and surveys but would provide a planning and coordination process to ensure the effectiveness of measures used to avoid and minimize adverse impacts on scientific survey activities.

Mitigation Measure	**Description**	**Expected Effect on Impacts from Action Alternatives**
	approval prior to BOEM's decision on its acceptance. Mitigation is necessary to ensure that NOAA Fisheries can continue to accurately, precisely, and timely execute our responsibilities to monitor the status and health of trust resources.	
Locations of boulders, berms, and protection measures	Locations of relocated boulders, created berms, and scour protection, including cable protection measures (i.e., concrete mattresses) should be provided to NMFS and the public as soon as possible to help inform marine users, including, but not limited to the fishing industry and entities conducting scientific surveys of potential gear obstructions.	This measure would not alter the impact determination for scientific research and surveys but would help to avoid and minimize adverse impacts on experimental design and sampling gear used to conduct these activities.

Table 3.17-3. Additional Mitigation and Monitoring Measures Under Consideration for Other Marine Uses (scientific research and surveys) (Appendix F, Table F-3)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Federal survey mitigation	There are 14 NMFS scientific surveys that overlap with wind energy development in the northeast region and nine of these surveys overlap with the Project. As per NMFS and BOEM Survey Mitigation strategy actions 1.3.1, 1.3.2, 2.1.1, and 2.1.2 (Hare et al. 2022), within 120 calendar days of COP Approval, the Lessee must submit to BOEM a draft survey mitigation agreement between NMFS and the Lessee. The survey mitigation agreement will describe how the Lessee will mitigate the Project impacts on the nine NMFS surveys. If after consultation with NMFS NEFSC, BOEM deems the survey mitigation agreement acceptable, the mitigation will be considered required as a term and condition of the Project's COP approval. As soon as reasonably practicable, but no later than 30 days after the issuance of the Project's COP Approval, the Lessee will initiate coordination with NMFS NEFSC to develop the survey mitigation agreement described above. Mitigation activities specified under the agreement will be designed to mitigate the Project impacts on the following NMFS NEFSC surveys: (a) Spring Bottom Trawl survey; (b) Autumn Multi-species Bottom Trawl survey; (c) Ecosystem Monitoring survey; (d) NARW aerial survey; (e) Aerial marine mammal and sea turtle survey; (f) Shipboard marine mammal and sea turtle survey; (g) Atlantic surfclam and ocean quahog survey; (h) Atlantic sea scallop survey; and (i) seal survey. At a minimum, the survey mitigation agreement will describe actions needed and the means to address impacts on the affected surveys due to the preclusion of sampling platforms and impacts on statistical designs. In terms of statistical design, the project will be viewed as a discrete stratum in surveys that use a random stratified design. Other anticipated Project impacts on NMFS surveys such as changes in habitat and increased operational costs due to loss of sampling efficiencies may also be addressed in the agreement. The survey mitigation agreement will identify activities that will result in the generation of data equivalent to data generated by NMFS's affected	This measure would complement existing EPMs. The federal survey mitigation strategy is a long-term plan to help ensure the quality of NOAA's fisheries surveys and data is maintained. Eventually, major long-term impacts to scientific research and surveys could be reduced to minor if monitoring becomes direct mitigation.

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
	surveys for the duration of the Project. The survey mitigation agreement will describe the implementation procedures by which the Lessee will work with NEFSC to generate, share, and manage the data required by NEFSC for each of the surveys impacted by the Project, as mutually agreed upon between the Lessee and NMFS/NEFSC. The survey mitigation agreement must also describe the Lessee's participation in the NMFS NEFSC Northeast Survey Mitigation Program to support activities that address regional-level impacts for the surveys listed above.	

3.17.2.22.1 Measures Incorporated into the Preferred Alternative

Mitigation measures required through completed consultations, authorizations, and permits listed in Table 3.17-4 and in Appendix F, Table F-2, are incorporated into Alternative G (Preferred Alternative). These measures, if adopted, would further define how the effectiveness and enforcement of EPMs would be ensured and would improve accountability for compliance with EPMs by requiring the submittal of plans for approval by the enforcing agency(ies) and by defining reporting requirements. Because these measures would ensure the effectiveness of and compliance with EPMs that are already analyzed as part of the Proposed Action, implementation of these measures would not further reduce the impact level of the Proposed Action from what is described in Section 3.17.2.

3.18 Recreation and Tourism

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to recreation and tourism from implementation of the Proposed Action and other considered alternatives.

3.19 Sea Turtles

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to sea turtles from implementation of the Proposed Action and other considered alternatives.

3.20 Visual Resources

3.20.1 Description of the Affected Environment and Environmental Consequences of the No Action Alternative for Visual Resources

Geographic analysis area: The GAA for non-historic visual resources encompasses a 40-mile radius extending from the boundary of the Lease Area and a 3-mile radius encompassing the OnSS and visually sensitive resources within New York, Connecticut, Rhode Island, and Massachusetts (Figure 3.20-1). The GAA comprises approximately 6,113 square miles of open ocean and 1,488 square miles of land and shoreline. Approximately 28 towns or communities in Rhode Island, 33 in Massachusetts, six in Connecticut, and two in New York are within the GAA (EDR 2023). This section addresses information and impacts related to non-historic visual resources. Information and impacts related to historic visual resources can be found in Section 3.10.

Visual resource impacts associated with the Project were evaluated and determined based primarily on information and findings associated with the RWF visual impact assessment (VIA) (EDR 2023) and the application of recently implemented BOEM impact assessment methodology, *Methodology for Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States* (seascape, landscape, and visual impact assessment [SLVIA]) (Sullivan 2021). At the request of BOEM, Revolution Wind applied the SLVIA methodology to assess impacts to the viewer's visual experience and impacts to ocean, seascape, and landscape character (Sullivan 2021:29–33). To the extent possible, Revolution Wind used previously documented information associated with the VIA, which pre-dates the SLVIA.

The SLVIA methodology was compared with the VIA to extract previously documented existing view information and landscape similarity zone characteristics (EDR 2023) and was translated into ocean character areas (OCAs), seascape character areas (SCAs), and landscape character areas (LCAs) at a generalized scale following the SLVIA as well as visual conditions and information. A total of 37 viewing condition scenarios (e.g., daytime, sunset, and nighttime) associated with 28 individual key observation points (KOPs) were assessed in the VIA and include photo simulations (EDR 2023:91–145). Additionally, OCA, SCA, and LCA visibility computations, based on SLVIA guidance and VIA information, were compiled and are presented in Tables G-VIS1a through G-VIS10c in Appendix G. For each action alternative, data were compiled and organized based on the best-known information provided in the VIA and compared to the Proposed Action. Additionally, the visibility analysis for each action alternative was analyzed associated with OCAs, SCAs, LCAs, and specially designated areas (SDAs) as was the proximity of KOPs in relation to action alternative variations (e.g., closest WTG and closest removed WTG based on the alternative) to provide geographic context of the overall distance in relation to the KOP. Analysis distances associated with KOPs may deviate between various resources (e.g., cultural and historic resources) based on location-specific analysis criteria. Identifying the closest WTG and closest removed WTG in relation to each KOP provides a tabular understanding of how action alternatives relate to each KOP (see Appendix G). Not all KOPs were evaluated for all action alternatives. The orientation of specific KOPs in relation to action alternatives was reviewed and selected for further analysis based on the geographic proximity of each action alternative.

Affected environment: Three distinct visual settings occur within the GAA and are categorized into OCAs, SCAs, and LCAs based on their inherent physical and built characteristics. These character areas aid in understanding the types of sensitive viewers and locations along with uses that occur within the GAA. The

OCA includes approximately 6,113 square miles of open ocean environment, which includes state waters (shoreline to 3 nm from shoreline) and federal waters (3 nm from shore and beyond) within the GAA. The OCA consists of the Atlantic Ocean and interconnected bodies of water such as Rhode Island Sound, Block Island Sound, Narragansett Bay, Fisher's Island Sound, Buzzards Bay, Mount Hope Bay, Vineyard Sound, Nantucket Sound, and other bays and coves. Depending on weather conditions, the texture of the ocean surface can range from smooth to choppy, and its color can range from blue, to silver, to dark gray. The ocean within the GAA can be categorized as a working water landscape that supports a variety of uses and associated human-made features, including recreational and commercial fishing, commercial shipping, ferry transportation, pleasure boating, and associated maritime activities and features (buoys, channel markers, warning lights, etc.) (EDR 2023). Within the GAA, SCAs and LCAs have been combined to include the land area inland from the ocean edge based on best available data sources and general descriptive characteristics using landscape similarity zone information from the VIA. SLVIA tables for each action alternative in Appendix G have landscape similarity zones from the VIA categorized as SCAs and LCAs based on descriptive characteristics and with SLVIA metrics applied as appropriate. The total land area associated with the SCA and LCA as described in the following narrative accounts for roughly 1,488 square miles within the GAA and is used for comparison purposes related to the visibility of alternatives (see Appendix G).

Areas that can be considered SCAs consist of Long Island; Block Island; Conanicut Island; Cuttyhunk Island; Prudence Island; Aquidneck Island; the Elizabeth Islands; Martha's Vineyard; Nantucket; and several smaller islands scattered along the coast of Connecticut, Massachusetts, and Rhode Island. Topography is typically undulating to gently rolling, with dunes and/or steep bluffs occurring along shorelines. Elevations range from sea level to a maximum of approximately 600 feet amsl near West Greenwich, Rhode Island. Cuttyhunk Island, Block Island, and Long Island have high points ranging from 130 to 200 feet amsl. Vegetation is typically characterized by a mix of scrub forest, grassy dunes, salt marshes, freshwater wetlands, and open fields (agricultural and successional). LCAs within the GAA consist of Connecticut, Rhode Island, and Massachusetts (mainland New York does not occur within the GAA) and are categorized by low hills, and valleys are primarily forested with scattered freshwater lakes, ponds, and occasional agricultural land. Residential and urbanized development occurs throughout the LCAs and consists of seasonal and year-round homes, villages, roads, and ports, with the highest density found in villages and towns. Outside of the village and town center areas, inland development is more scattered at a lower density and is in a largely forested landscape (EDR 2023).

The VIA (EDR 2023) located in COP Appendix U3 further categorizes the above visual settings into landscape similarity zones, which are based on the similarity of landscape character and visual features such as landform, vegetation, and water and land use patterns such as recreation, residential and commercial development, and transportation. Descriptions of each of the 17 landscape similarity zones identified within the GAA can be found in the VIA (EDR 2023:15–25).

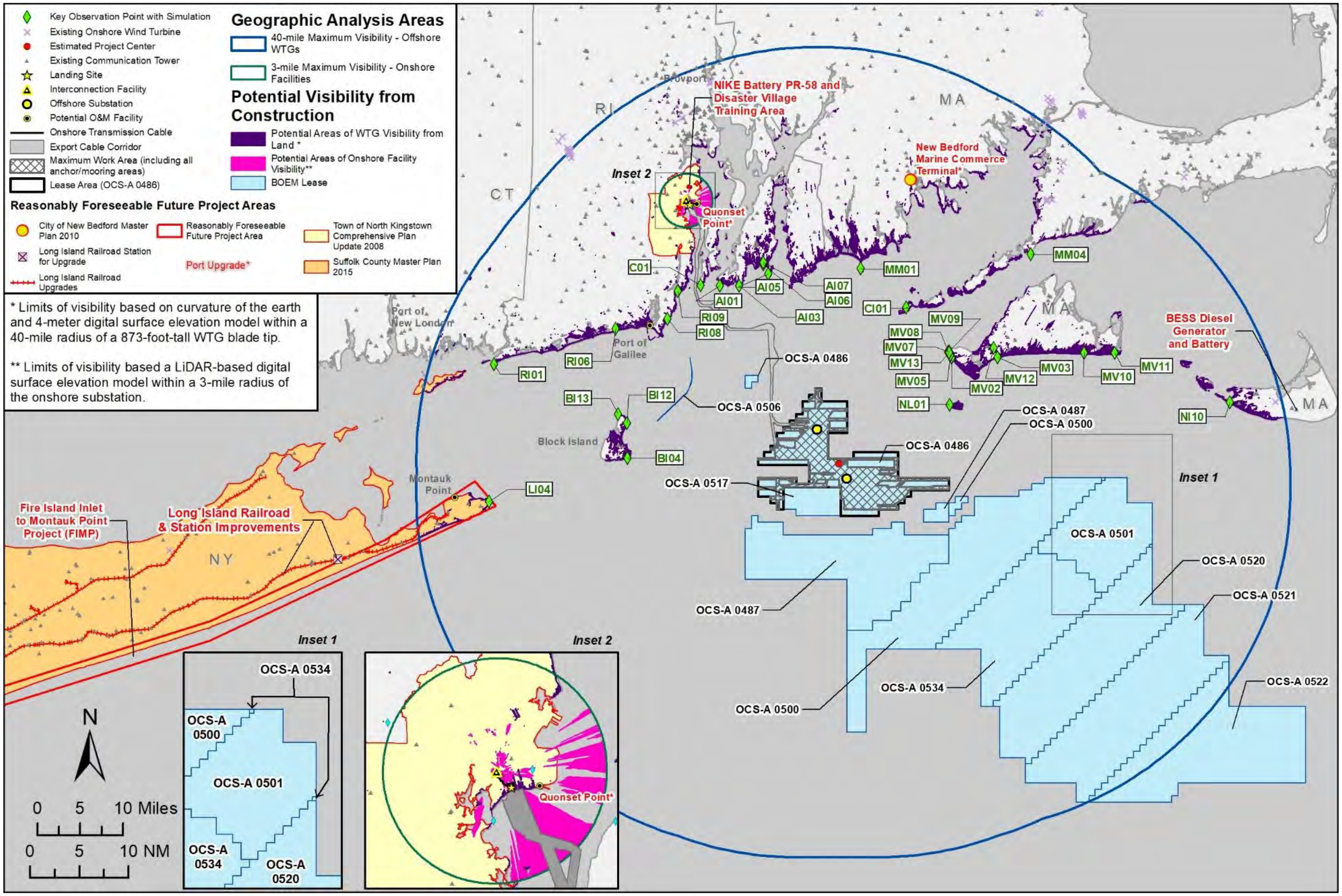

Figure 3.20-1. Geographic analysis areas for visual resources.

Viewers within the GAA have been categorized into five general user groups (local residents, through-travelers, tourists and vacationers, recreational users, and the fishing community [recreational and commercial]) based on their relative viewer experience within the GAA and their perceived sensitivity to visual changes in the landscape. Local residents are those who live, work, and travel for their daily business within the GAA. They generally view the landscape from their yards, homes, local roads, and places of employment. Residents' sensitivity to visual quality is variable, and how they experience their surroundings on a day-to-day basis is based on the location and or locations they visually interact with either in residential, workplace, or recreational settings. Through-travelers are typically vehicle-based and moving, thus having a relatively narrow field of view oriented along the axis of the roadway, and are most often destination-oriented, viewing the landscape either from the driver or passenger perspective. Through-travelers who are not residents of the area or vacationers are unlikely to be particularly sensitive to visual change and often engage with visual experiences at that time and place rather than over a consistent period of time where visual change can be more noticeable. Tourists and vacationers consist of out-of-town visitors and seasonal-weekend residents who come to the area to experience its scenic and recreational resources. Tourists and vacationers in the area are generally involved in outdoor recreational activities in settings where the experience can be directly connected to the activity or location, such as parks, trails, and beaches, and in natural settings such as forests, dunes, and the ocean.

Recreational users are generally considered to have relatively high sensitivity to aesthetic quality and changes in landscape character. Information regarding the types of recreation for both onshore and offshore users is described in Section 3.18. The fishing community is represented by recreational and commercial fishermen who work in and experience the coastal and open ocean environment on a regular basis. Despite the focused activity associated with harvesting seafood, the fishing community is particularly sensitive to changes to the visual seascape because there is often nothing in the immediate environment except for open ocean and horizon. The fishing community can have prolonged visual exposure to the open ocean, seascape, and coastal environment, in which fleets spend hours to days setting gear and harvesting fish. Those who use the ocean recreationally (e.g., boating, whale watching, sightseeing) and commercially (e.g., fishing, commercial transportation) are distinct user groups that would have foreground and middle ground views of the Project, whereas the other user groups are largely land-based and restricted to background and extended background views (EDR 2023).

3.20.2 Environmental Consequences

3.20.2.1 Relevant Design Parameters, Impact-Producing Factors, and Potential Variances in Impacts

The PDE provides for a range of WTGs sized from 8 to 12 MW. The analysis of impacts to visual resources is based on the PPAs being met using 648-foot 8-MW WTGs. This would result in a total of up to 100 WTGs and up to two OSSs for a total of 102 structures in the Lease Area.

If Revolution Wind instead installs sixty-four 12-MW WTGs, the maximum height of the blade tip for WTGs would be 873 feet above the surface compared to 648 feet for the 8-MW WTGs. Because the WTGs would exceed 699 feet, BOEM guidance, consistent with FAA requirements, would require additional mid-tower lighting in addition to lighting at the top of the nacelle (BOEM 2019). BOEM guidance further recommends that lighting color be of a red infrared wavelength between 675 and 900 nanometers based on LED light sources and that red flashing lights flash simultaneously at 30 flashes per minute (BOEM 2019). Although the 12-MW WTG option would reduce the number of WTGs, the 226-

foot taller WTGs and additional lighting would be similar in contrast in the seascape character and potentially would result in greater visual impacts within the GAA associated with the viewers' visual experience, as the WTGs may be visible at greater distances in comparison with the 8-MW WTGs.

See Appendix E1 for a summary of IPFs associated with visual resources across all action alternatives. IPFs that are either not applicable to the resource or determined by BOEM to have a negligible adverse effect are excluded from Chapter 3 and provided in Table E2-11 in Appendix E1. Offshore and onshore IPFs are addressed separately in the analysis if appropriate for the resource; not all IPFs have both an offshore and onshore component. Where feasible, calculations for specific alternative impacts are provided in Appendix E4 to facilitate reader comparison across alternatives.

Table 3.20-1 provides a summary of IPF findings carried forward for analysis in this section. Each alternative analysis discussion consists of the construction and installation phase, the O&M phase, the decommissioning phase, and the cumulative analysis. If these analyses are not substantially different, then they are presented as one discussion.

A detailed analysis of the Proposed Action is provided following the table. A detailed analysis of other considered action alternatives is also provided below the table if the analysis indicates that the alternative(s) would result in substantially different impacts than the Proposed Action. Analysis findings that identify an action alternative (C, D, E, F, or G) that has the greatest potential for reduced visual impacts (least impactful) as a result of the removal of turbines in relation to KOPs or character areas have been carried forward in Table 3.20-1 in lieu of describing impacts for all action alternatives. Overall SLVIA impact summaries for KOPs, SDAs, and character areas are provided in Tables 3.20-2 through 3.20-4. Further details and information related to all action alternatives are comprehensively compiled in Appendix G. The Conclusion section within each alternative discussion includes rationale for the effects determinations.

Under all action alternative configurations (options), overall impacts to non-historic visual resources from any alternative would range from long term **negligible** to **major** adverse for KOPs, SDAs, and character areas related to the overall visual change and magnitude of change based on analysis findings that indicate the largest number of overall impact determinations. Individual KOPs where sensitivity may influence impacts such as tribal concerns or recreation associated with scenic beaches may indicate higher impacts and are individually identified in Appendix G. Impacts would be substantial, but the resource would recover completely when the impacting agents are removed.

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Table 3.20-1. Alternative Comparison Summary for Visual Resources

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
Light	**Offshore**: Development of offshore wind lease areas would increase the amount of offshore light sources associated with construction and installation, O&M, and decommissioning during the life of future projects. Lighting associated with night construction and decommissioning for future projects would be localized and temporary. However, light sources, depending on quantity, intensity, and location, could be visible from unobstructed onshore and offshore KOPs based on viewer distance. The existing offshore wind lease areas, following established grid spacing guidelines within the RI/MA and MA WEAs, have space for up to an estimated 936 WTGs. BOEM lighting guidelines require a minimum of three red flashing lights at the midsection of each tower and one at the top of each WTG nacelle. The potential full build-out of the existing offshore wind lease areas could result in up to 936 WTGs with lighting and would have long-term **minor** to **major** adverse impacts to onshore and offshore KOP distance and angle of view, assuming no obstructions. Under the No Action Alternative, visual resource impacts would be short term during construction and long term during O&M, with **negligible** to **major** adverse impacts to KOPs, character areas, and SDAs based on the observed warning light distances discussed in Section 3.20.2.2.2. Impacts to nighttime seascape character would also be short term during construction and long term during O&M, with **negligible** to **major** adverse impacts based on the relationship of the lease areas inherent nighttime visual characteristics and	**Offshore**: The Proposed Action would require nighttime lighting for construction vessels traveling and working within the Lease Area, as well as the addition of warning lighting systems at each WTG and OSS during an 8-month construction period. This lighting could be visible and impact the viewer's nighttime visual experience and inherent nighttime seascape character. Nighttime visibility of warning lighting may be perceived anywhere from approximately 23.3 nm (26.8 miles) to 31.3 nm (36 miles) from the viewer or farther. During construction, visual impacts to the viewer's nighttime visual experience and inherent nighttime character would be temporary when associated with vessel traffic and construction lighting. These impacts would be **negligible** to **major** adverse based on viewer distance and existing night sky environment. Aquinnah Overlook (MV07), the closest occupied KOP to the Proposed Action, is located approximately 11.10 nm (13.7 miles) distant. The farthest KOP from the Proposed Action, Madeaket Beach (NI10), is located approximately 30.0 nm (34.6 miles) distant. These two KOPs are the representative minimum and maximum KOP distances in relation to perceivability of warning lighting. KOP distances in relation to the nearest WTG are described in Appendix G. During O&M, the Proposed Action would contribute to nighttime lighting due to required warning lighting on up to 100 WTGs and two OSSs. Revolution Wind has committed to implementing ADLS as an EPM to reduce the duration of lighting impacts associated with the Project. Because of the limited duration and frequency of anticipated warning lighting activations with ADLS and the visibility of warning lighting, the Proposed Action would result in short duration, long-term intermittent **negligible** impacts when lights are off to **major** adverse impacts to KOPs and character areas when lights are activated. Not all KOPs or character areas would experience the same level of impact due to variances in atmospheric conditions and natural and physical barriers to the view.	**Offshore**: No measurable change from Proposed Action construction impacts is anticipated under Alternatives C through F because the number and duration of construction vessels and work areas requiring nighttime lighting, as well as the assembly of WTGs and associated OSS warning lighting, would result in temporary long-term **negligible** to **major** adverse impacts based on viewer distance and existing night sky condition, similar to the Proposed Action. Alternatives C through F would reduce nighttime O&M lighting by a range of 7% to 43%, across the alternative scenarios, as compared to the maximum-case scenario for the Proposed Action due to required warning lighting of fewer WTGs. Alternative D1+D2+D3 would have the greatest reduction of lighting-related impacts within the northeastern and northwestern portions of the Lease Area, which are in closest proximity to more KOPs. Impacts associated with Alternative D1+D2+D3 would be **negligible** to **minor** adverse based on viewer distance (see Section 3.20.2.2.2) and the existing night sky environment, and given this, it would have the fewest impacts to visual resources collectively. KOP distances in relation to WTGs are described in Appendix G. Offshore construction activities would add new WTGs and two OSSs as compared to the No Action Alternative. Construction vessels would employ navigational safety lighting, and offshore structures would employ aviation and navigation hazard lighting. Lighting from Alternatives C through F would contribute to an approximately 6% to 10% increase in lighting sources from past, present, and reasonably foreseeable future projects within the GAA. Cumulatively, when combined with other past, present, and reasonably foreseeable projects, Alternatives C through F would result in long-term **negligible** adverse impacts when lights are off to **major** adverse impacts when lights are activated on nighttime viewers and the existing night sky environment, with Alternative E1 having the greatest contribution to reducing cumulative lighting impacts.				**Offshore**: Similar to Alternatives C through F, no measurable change from construction impacts under Alternative G is anticipated because the number and duration of construction vessels and work areas requiring nighttime lighting, as well as the assembly of WTGs and associated OSS warning lighting, would result in temporary long-term **negligible** to **major** adverse impacts based on viewer distance and existing night sky condition, similar to the Proposed Action. Alternative G would reduce nighttime O&M lighting by 23.5% to 42.4%, as compared to the maximum-case scenario for the Proposed Action, due to required warning lighting of fewer WTGs. Alternatives G2 and G3 would have the greatest reduction of lighting-related impacts within the northern, northeastern, and southwestern portions of the Lease Area, which are in proximity to KOPs associated with Rhode Island, Martha's Vineyard and Block Island. Impacts associated with Alternatives G2 and G3 would be **negligible** to **minor** adverse based on viewer distance (see Section 3.20.2.2.2) and the existing night sky environment, and given this, they would have the fewest impacts to visual resources collectively. KOP distances in relation WTGs are described in Appendix G. Similar to Alternatives C through F, offshore construction activities would add new WTGs and two OSSs to the No Action Alternative. Construction vessels would employ navigational safety lighting, and offshore structures would employ aviation and navigation hazard lighting. Lighting from Alternative G would contribute to an approximately 7.5% (Alternatives G1, G2, and G3) to 9% (Alternative G) increase in lighting sources from past, present, and reasonably foreseeable future projects within the GAA. Cumulatively, when combined with other past, present, and reasonably foreseeable projects, Alternative G would result in long-term

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	projects' inconsistences with those nighttime characteristics. After decommissioning, the adverse impacts associated with O&M would cease.	Impacts during decommissioning would be similar to the impacts during construction and installation: long term, short duration, and intermittent **negligible** to **major** adverse. Lighting from the Proposed Action would add up to 102 in-water structures to the lighting impacts from past, present, and reasonably foreseeable future projects (assumed to be up to 893 structures) for a combined total of up to 995 lighted structures within the GAA, a 11% increase in lighting compared to the No Action Alternative (Table E4-1). Nighttime vessel and construction area lighting during construction of the Proposed Action would be limited in duration and cease when construction is complete. Atmospheric and environmental conditions would influence visibility and perceivability from KOPs, character areas, and SDAs. Cumulatively, when combined with other past, present, and reasonably foreseeable projects, the Proposed Action would result in long-term **negligible** adverse impacts when lights are off to **major** adverse impacts to nighttime viewers and the existing night sky environment when lights are activated.					**negligible** adverse impacts when lights are off to **major** adverse impacts when lights are activated on nighttime viewers and the existing night sky environment, with Alternatives G1, G2, and G3 having the greatest contribution to reducing cumulative lighting impacts based on the number of associated WTGs (65) and OSSs (two).
	Onshore: Future onshore components of offshore projects could require OnSSs, ICFs, O&M facilities, and port upgrades depending on project needs and could introduce additional or new infrastructure elements into SCAs and/or LCAs. However, specific locations and project designs have not been determined. Infrastructure and associated nighttime lighting to support other offshore wind projects (e.g., OnSS or O&M facilities) are anticipated to occur in areas of existing development or where similar infrastructure and development exist to aid in co-location of similar resources. Therefore, additional onshore nighttime lighting sources associated with infrastructure to support future offshore wind projects would be a noticeable change over time and would have long-term **negligible** to	**Onshore**: Light and noise from onshore construction activities could temporarily adversely impact viewers if located near the landing site, onshore cable route, or proposed onshore facilities. It is assumed that construction activities would occur during daylight hours. Fifteen publicly accessible KOPs were identified in the Visual Resource Assessment and Historic Resources Visual Effects Analysis within 3 miles of the OnSS and ICF with the closest at approximately 0.6 mile (Narraganset Bay) (EDR 2021). Impacts to these KOPs are not anticipated due to distance, intervening vegetation, and existing lighting sources. Approximately 500 feet south and west of the OnSS and ICF are residential properties consisting of single-family and multifamily residences. Dense stands of tall trees (40 feet tall on average) provide a natural buffer between the OnSS and ICF and the residences, which is anticipated to reduce any nighttime-related impacts to nearby residences to **negligible** adverse.	**Onshore:** Alternatives C through F would not alter impacts from onshore activities; therefore, impacts would be the same as those described for the Proposed Action: temporary **negligible** to **minor** adverse to potential nighttime viewers and the existing night sky environment based on viewer location and perspective in relation to existing onshore light sources.				**Onshore:** Similar to Alternatives C through F, impacts associated with Alternative G would be the same as the Proposed Action: temporary **negligible** to **minor** adverse to potential nighttime viewers and the existing night sky environment based on viewer location and perspective in relation to existing onshore light sources.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	moderate adverse impacts for the life of the projects.	Onshore lighting related to construction activity for the O&M facility, located within an existing industrial use area with existing lighting, would create short-term **negligible** adverse impacts to potential nighttime viewers and the existing night sky environment due to the nature of the construction lighting, which would be contained to the existing property and be similar in nature to surrounding facilities and light sources. The nighttime lighting impacts of the OnSS, ICF, and O&M facility would cause long-term **negligible** adverse impacts to potential nighttime viewers and the existing night sky environment during Project O&M. Impacts associated with the OnSS and ICF would be reduced by the use of switched vs. motion operational lighting, which would comply with local lighting regulations. Impacts associated with the O&M facility would be associated with localized light sources and operational uses, similar to surrounding infrastructure. Onshore construction and installation would add an O&M facility, OnSS, and ICF to the No Action Alternative. These onshore structures and nighttime lighting sources are anticipated to occur in areas of existing development or where similar infrastructure and development exists. Therefore, when considered cumulatively with past, present, and reasonably foreseeable activities, the Proposed Action would result in long-term **negligible** adverse impacts to nighttime viewers and the existing night sky environment.					
Presence of structures	**Offshore**: Based on the Proposed Action and action alternatives analysis findings (Section 3.20.2.2 and Appendix G), if future offshore wind projects are implemented, the effects of installed WTGs and associated infrastructure on KOPs, character areas, and SDAs, when viewed from both onshore and offshore locations, would result in long-term **negligible** to **major** adverse visual impacts. The impacts experienced at KOPs, character areas, and SDAs would be dependent upon distance and orientation to the project, the degree of visibility considering lighting and	**Offshore**: The addition of Project structures with navigation and aviation lighting over the 8-month construction period, coupled with the temporary increase and concentration in construction related vessel activity, would result in short-term to long-term **negligible** to **major** adverse impacts to KOPs. Sixteen of the 37 KOPs would experience major adverse impacts. Impacts to SDAs would range from **negligible** to **major** adverse with approximately 30,208 acres of visibility or 15.5 % of the approximately 208,009 acres of SDAs. Impacts to the OCA as a result of the construction activities noted above would be **major** adverse (approximately 5,882 square miles or 96.2 % of the total OCA within the GAA would have views of the	**Offshore**: The layout and construction activities proposed under Alternatives C through F would include the same activities and construction sequencing as the Proposed Action and would result in similar anticipated impacts. Therefore, the construction and installation of offshore Project structures would have long-term **negligible** to **major** adverse impacts to KOPs, character areas, and SDAs under Alternatives C through F, similar to those of the Proposed Action. Alternatives C1 and C2: Because of the placement of WTGs, Alternative C1 would result in fewer impacts to KOPs than Alternative C2. Alternative C1 would result in short-term to long-term **negligible** to **major** adverse impacts to KOPs within the GAA, with 7 of the 17 selected KOPs having major adverse impacts, five KOPs having moderate adverse impacts, and three KOPs having minor adverse impacts. Impacts to SDAs would range from **negligible** to **major** adverse, with approximately 29,968 acres of visibility of Alternative C2 (14.4%) of the approximately 208,009 acres of SDAs as compared to 30,059 acres of Alternative C1. Impacts to the OCA would be **major** adverse, similar to other action alternatives, with Alternatives C1 and C2 visible to approximately 96% of the OCA. Impacts to SCAs and LCAs would range from				**Offshore**: Similar to Alternatives C through F, the layout and construction activities proposed under Alternatives G would include the same activities and construction sequencing as the Proposed Action and would result in similar anticipated impacts. Therefore, the construction and installation of offshore Project structures would have long-term **negligible** to **major** adverse impacts to KOPs, character areas, and SDAs under Alternatives G, similar to those of the Proposed Action Because of the placement of WTGs in relation to KOPs, Alternatives G2 and G3 would have the greatest reduced visual impact as

<table>
<tr><th>Impact-Producing Factor</th><th>No Action Alternative</th><th>Alternative B (Proposed Action)
up to 100 WTGs</th><th>Alternative C
(Habitat Alternative)
64–65 WTGs</th><th>Alternative D
(Transit Alternative)
78–93 WTGs</th><th>Alternative E
(Viewshed Alternative)
64–81 WTGs</th><th>Alternative F
(Higher Capacity Turbine Alternative)
56 WTGs</th><th>Alternative G
(Preferred Alternative)
65 WTGs</th></tr>
<tr><td></td><td>atmospheric conditions, and the perceivable contrast, dominance, and scale of WTGs and OSSs along the horizontal plane of the ocean.</td><td>Proposed Action. Impacts to SCAs and LCAs would range from minor to moderate adverse based on the sensitivity and degree of magnitude in relation to the character area; overall approximately 35 square miles (2.4 %) of the combined SCAs and LCAs would have visibility of the Project within the GAA. Of the 60 impact determinations associated with KOPs, character areas, and SDAs associated with the Proposed Action, 21 major, 21 moderate, 11 minor and 7 negligible impacts were determined. Further information related to impacts associated with the Proposed Action is located in Appendix G. Further information related to impacts associated with the Proposed Action is located in Appendix G (see Tables G-VIS1a through G-VIS2e).

WTGs would be more visually apparent viewed from the northern and easterly shorelines of Rhode Island and Massachusetts. The up to 100 WTGs and two OSSs would become less perceivable as the distance from KOPs and/or character areas increases. Atmospheric and environmental factors such as haze, sun angle, time of day, cloud cover, fog, sea spray, and wave action would also influence visibility and perceivability from KOPs (e.g., NI10 - modified haze/sun, MV12 day vs. night, MV05 day vs. night), which may not be depicted in all visual simulations, or from other non-simulated locations that may have visibility within character areas. It is anticipated therefore that Project O&M would result in long-term negligible to major adverse impacts.

The Proposed Action would add up to 100 WTGs and two OSSs to the No Action Alternative. As a result, approximately 90% of the total potential WTGs and OSSs in the GAA (up to 995) would be associated with other future offshore wind development projects beyond the Proposed Action and at distances from KOPs, character areas, and SDAs where atmospheric conditions and curvature of the Earth influence visibility. When combined with other past, present, and reasonably foreseeable projects, the Proposed Action would result in long-term negligible to major adverse cumulative impacts to KOPs, character areas, and SDAs. Adverse impacts would be removed at Project decommissioning.</td><td colspan="4">minor to moderate adverse based on the sensitivity and degree of magnitude in relation to the character area; overall, Alternative C2 would be visible to approximately 34.7 square miles (2.3%) of the combined SCAs and LCAs within the GAA. Because of the similarity in placement of WTGs, Alternatives C1 and C2 would result in similar impacts, and both alternatives would result in fewer impacts than the Proposed Action. Of the 40 impact determinations associated with KOPs, character areas, and SDAs, 10 major, 14 moderate, seven minor, and five negligible adverse impacts were determined for Alternative C1 (see Tables G-VIS3 and G-VIS4c).

Alternative D alternatives: Of the seven Alternative D alternatives, Alternative D1+D2+D3 would result in the fewest number of adverse impacts because of the combination of removed turbines within the Lease Area as compared to the maximum-case scenario for the Proposed Action. Alternative D1+D2+D3 would result in short-term to long-term negligible to major adverse impacts to KOPs within the GAA, with 12 of the 37 selected KOPs having major adverse impacts, 14 KOPs having moderate adverse impacts, and 11 KOPs having minor to negligible adverse impacts. Impacts to SDAs would range from negligible to major adverse, with approximately 28,840 acres of visibility of Alternative D1+D2+D3 (13.9%) of the approximately 208,009 acres of SDAs. Impacts to the OCA would be major adverse, similar to other action alternatives, with the Project visible to approximately 96% of the OCA. Impacts to SCAs and LCAs would range from minor to moderate adverse, similar to the Proposed Action based on the sensitivity and degree of magnitude in relation to the character area. Overall, approximately 31.1 square miles (2.1%) of the combined SCAs and LCAs would have visibility of Alternative D1+D2+D3 within the GAA. Of the 60 impact determinations associated with KOPs, character areas, and SDAs, 15 major, 24 moderate, 12 minor, and nine negligible adverse impacts were determined for Alternative D1+D2+D3 (see Tables G-VIS5a and G-VIS6c).

Alternatives E1 and E2: Because of the placement of WTGs, Alternative E1 would result fewer impacts than Alternative E2. Alternative E1 would result in short-term to long-term negligible to major adverse impacts to KOPs within the GAA, with four of the 21 selected KOPs having major adverse impacts, 12 KOPs having moderate adverse impacts, and five KOPs having minor to negligible adverse impacts. Impacts to SDAs would range from negligible to major adverse, with approximately 29,085 acres of visibility of Alternative E1 (14.0%) of the approximately 208,009 acres of SDAs. Impacts to the OCA would be major adverse, similar to the Proposed Action, with the alternative visible to approximately 96% of the OCA. Impacts to SCAs and LCAs would range from minor to moderate adverse based on the sensitivity and degree of magnitude in relation to the character area. Overall, Alternative E1 would be visible to approximately 32.7 square miles (2.2%) of the combined SCAs and LCAs within the GAA. Of the 44 impact determinations associated with KOPs, character areas, and SDAs, eight major, 21 moderate, seven minor, and eight negligible adverse impacts were determined for Alternative E1 (see Tables G-VIS7 and G-VIS8c for individual KOP impacts and Section 3.20.2.5 for example impact comparison).

Alternative E2 would result in short-term to long-term negligible to major adverse impacts to KOPs within the GAA; with one of the 16 selected KOPs having major adverse impacts, six KOPs having moderate adverse impacts, and nine KOPs having minor to negligible adverse impacts. Impacts to SDAs would range from negligible to major adverse with approximately 29,385 acres of visibility of Alternative E2 (14.1.0 %) of the approximately 195,701 acres of SDAs. Impacts to the OCA would be major adverse, similar to the Proposed Action, with the alternative visible to approximately 96% of the OCA. Impacts to SCAs and LCAs would range</td><td>compared to the Proposed Action. Information related to Alternatives G and G1 is included in Appendix G.

Alternative G2 would result in a slightly lesser degree of impacts than Alternative G3. Alternative G2 would result in short-term to long-term negligible to major adverse impacts to KOPs within the GAA, with one of the 19 selected KOPs having major adverse impacts, 10 KOPs having moderate adverse impacts, and four KOPs having minor to negligible adverse impacts. Comparatively, Alternative G3 would have 10 of the 22 selected KOPs with major adverse impacts, seven KOPs with moderate adverse impacts, one KOP with minor impacts, and four with negligible adverse impacts.

Impacts to SDAs would range from negligible to major adverse for Alternative G, with Alternative G2 having the greatest reduced visibility with approximately 30,499 acres of visibility (14.6%) of the approximately 208,009 acres of SDAs as compared to 30,477 acres of visibility (14.7%) associated with Alternative G3. Impacts to the OCA would be major adverse, similar to other action alternatives, with Alternative G visible to approximately 96% of the OCA.

Impacts to SCAs and LCAs would range from minor to moderate adverse based on the sensitivity and degree of magnitude in relation to the character area; overall, Alternative G3 would be the least visible to approximately 33.4 square miles (2.2%) of the combined SCAs and LCAs within the GAA as compared 33.5 square miles (2.3%) associated with Alternative G2.

Of the 42 impact determinations associated with KOPs, character areas, and SDAs, six major, 19 moderate, eight minor, and nine negligible adverse impacts were determined for Alternative G2 as compared to 10 major, seven moderate, one minor, and four negligible adverse impacts associated with Alternative G3 (see Tables G-VIS9 to G-VIS10c).</td></tr>
</table>

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
			from **minor** to **moderate** adverse based on the sensitivity and degree of magnitude in relation to the character area. Overall, Alternative E2 would be visible to approximately 33.5 square miles (2.3%) of the combined SCAs and LCAs within the GAA. Of the 39 impact determinations associated with KOPs, character areas, and SDAs, five major, 15 moderate, seven minor, and 12 negligible adverse impacts were determined for Alternative E2 (see Tables G-VIS7 and G-VIS8c). Alternative F: Alternative F, when combined with other action alternatives, could reduce the number of WTGs installed in the Lease Area by 7% to 44% as compared to the maximum potential 100 WTGs installed under the Proposed Action. The potential reduction of impacts would depend on viewer distance and would be focused primarily on locations in closest proximity to the area of reduced WTGs. A reduction in WTGs installed would be expected to result in long-term **negligible** to **major** adverse impacts to KOPs, character areas, and SDAs. However, the application of Alternative F cannot be fully evaluated until the specific WTGs to be removed are identified. Further information related to impacts associated with Alternatives C, D, and E is included in Appendix G. Alternatives C through F would add between 66 and 83 structures (WTGs and OSSs) to the estimated up to 893 structures under the No Action Alternative within the GAA. Of the four action alternatives identified as resulting in the greatest reduction of impacts, Alternative D1+D2+D3 would result in the smallest area of visibility (approximately 31 square miles of SCA and LCA). Alternative D1+D2+D3 when combined with other past, present, and reasonably foreseeable projects would result in long-term **negligible** to **major** adverse impacts to KOPs, character areas, and SDAs in comparison to the No Action Alternative.				
	Onshore: Future onshore components of offshore wind projects could require OnSSs, ICFs, O&M facilities, and port upgrades depending on project needs and could introduce additional or new infrastructure elements into the characteristic landscape over a period of time, although specific locations and design have not been determined. Infrastructure to support other offshore wind projects (e.g., OnSS or O&M facilities) are anticipated to occur in or be co-located in areas of existing development associated with SCAs or LCAs where similar infrastructure and development exist. Therefore, the addition of onshore structures to support other offshore wind projects would be noticeable over time and would have long-term **negligible** to **minor** adverse impacts to identified KOPs, character areas, and SDAs based on their location in relation to other	**Onshore**: The construction and installation of the OnSS and ICF would occur during an approximate 18-month construction period. During this period, there would be an noticeable change over time in the immediate foreground of the OnSS and ICF because of the addition of the facilities. The O&M facility at the Port of Davisville at Quonset Point would be similar to existing industrial infrastructure, consisting of large geometric features. Therefore, the addition of Project structures associated with the OnSS, ICF, and O&M facility would create long-term **negligible** to **minor** adverse impacts to KOPs, character areas, and SDAs until the projects are decommissioned. Where visible within immediate foreground distances, the OnSS and ICF would introduce new industrial-utility structures. However, the OnSS and ICF would be located adjacent to the existing Davisville Substation and would not be out of scale or character with the existing development in the vicinity, which ranges from transit rail and four-lane roadway to residential to heavy industrial within 0.5 mile. For this reason, the OnSS and ICF	**Onshore**: There are no design differences between Alternatives C through F in onshore activities; therefore, impacts resulting from onshore activities would be the same as those described for the Proposed Action: long-term **negligible** to **minor** adverse to viewers based on viewer location and perspective in relation to existing onshore structures and development as well as associated LCAs.				**Onshore**: Similar to Alternatives C through F, impacts resulting from onshore activities associated with Alternative G would be the same as those described for the Proposed Action: long term **negligible** to **minor** adverse to viewers based on viewer location and perspective in relation to existing onshore structures and development as well as associated LCAs.

Impact-Producing Factor	No Action Alternative	Alternative B (Proposed Action) up to 100 WTGs	Alternative C (Habitat Alternative) 64–65 WTGs	Alternative D (Transit Alternative) 78–93 WTGs	Alternative E (Viewshed Alternative) 64–81 WTGs	Alternative F (Higher Capacity Turbine Alternative) 56 WTGs	Alternative G (Preferred Alternative) 65 WTGs
	infrastructure and facilities until the projects are decommissioned.	would result in long-term **negligible** adverse impacts to KOPs, character areas, and SDAs. Onshore construction and installation would add an, ICF, and OnSS to the No Action Alternative. The O&M facility would use existing structures. The Proposed Action does not include any updates to ports. Any potential future port upgrades required to service the offshore wind industry could result in similar **negligible** adverse visual impacts to KOPs, character areas, and SDAs. The Proposed Action when combined with past, present, and reasonably foreseeable activities would result in long-term **negligible** adverse cumulative impacts to KOPs, character areas, and SDAs.					

Table 3.20-2. SLVIA Overall Impacts Per KOP by Alternative as Determined in Appendix G Tables G-VIS1b, G-VIS3, G-VIS5b, G-VIS7, and G-VIS9

KOP Number	KOP Name	Overall Impact Level of Proposed Action (Alternative B)	Overall Impact Level of Alternative C	Overall Impact Level of Alternative D	Overall Impact Level of Alternative E	Overall Impact Level of Alternative F*	Overall Impact Level for Alternative G
AI01	Brenton Point State Park	Moderate	N/A	Moderate	Negligible	–	Moderate
AI01	Brenton Point State Park – Night	Major	N/A	Moderate	Moderate	–	Moderate
AI03	Newport Cliff Walk	Moderate	N/A	Moderate	Negligible	–	Moderate
AI05	Sachuest Point National Wildlife Refuge	Major	N/A	Moderate	Negligible	–	Moderate
AI06	Sachuest Beach (Second Beach)	Moderate	N/A	Minor	Negligible	–	Minor
AI07	Hanging Rock (Norman Bird Sanctuary)	Major	N/A	Moderate	Negligible	–	Moderate
C01	Beavertail Lighthouse	Minor	N/A	Minor	N/A	–	Minor
CI01	Chuttyhunk Island	Major	Major	Major	Moderate	–	Moderate
MM01	Gooseberry Island	Minor	Minor	Minor	Negligible	–	Moderate
MM04	Nobska Lighthouse	Minor	N/A	Minor	Negligible	–	Negligible
MV02	Philbin Beach	Moderate	Moderate	Moderate	Moderate	–	Moderate
MV03	Lucy Vincent Beach	Moderate	N/A	Minor	Moderate	–	Moderate
MV03	Lucy Vincent Beach – Sunset	Major	N/A	Moderate	Major	–	Moderate
MV05	Moshup Beach	Moderate	Major	Major	Moderate	–	Major
MV05	Moshup Beach – Sunset	Major	Major	Moderate	Moderate	–	Major
MV07	Aquinnah Overlook	Major	Moderate	Major	Moderate	–	Major
MV07	Aquinnah Overlook – Sunset	Major	Major	Major	Moderate	–	Major
MV07	Aquinnah Overlook – Night	Major	Major	Major	Moderate	–	Major
MV09	Gay Head Lighthouse	Major	Moderate	Major	Moderate	–	Major
MV10	South Beach State Park	Moderate	Major	Moderate	Moderate	–	Moderate
MV11	Wasque Point	Minor	Minor	Minor	Minor	–	Minor
MV12	Peaked Hill Reservation	Major	Major	Major	Moderate	–	Major
MV12	Peaked Hill Reservation – Sunset	Major	Major	Major	Major	–	Major
MV13	Edwin DeVries Vanderhoop Homestead	Major	Moderate	Major	Major	–	Major
NL01	Nomans Land Island NWR *(not occupied)*	Major	Moderate	Major	Moderate	–	Major
NL01	Nomans Land Island NWR – Sunset *(not occupied)*	Major	Major	Major	Major	–	Major
NI10	Madaket Beach	Negligible	Minor	Negligible	Minor	–	Negligible
LI04	Montauk Point State Park	Negligible	N/A	Negligible	N/A	–	Negligible
LI04	Montauk Point State Park – Night	Negligible	N/A	Negligible	N/A	–	Negligible
BI04	Southeast Lighthouse	Moderate	N/A	Moderate	Moderate	–	Moderate

KOP Number	KOP Name	Overall Impact Level of Proposed Action (Alternative B)	Overall Impact Level of Alternative C	Overall Impact Level of Alternative D	Overall Impact Level of Alternative E	Overall Impact Level of Alternative F*	Overall Impact Level for Alternative G
BI04	Southeast Lighthouse – Night	Major	N/A	Major	Moderate	–	Moderate
BI12	Clayhead Trail	Moderate	N/A	Moderate	Minor	–	Moderate
BI13	North Light	Moderate	N/A	Moderate	Minor	–	Moderate
RI01	Watch Hill Lighthouse	Minor	N/A	Negligible	N/A	–	Negligible
RI06	Trustom Pond NWR	Minor	N/A	Minor	Negligible	–	Negligible
RI08	Scarborough Beach State Park	Moderate	N/A	Moderate	Moderate	–	Minor
RI09	Narragansett Beach	Moderate	N/A	Moderate	Moderate	–	Moderate

Notes: Nighttime impacts would be reduced to negligible, as described in EIS Table 3.3-2. Definitions of Potential Adverse Impact Levels, when FAA warning lights are not activated though the use of ADLS.

* Alternative F cannot be fully evaluated using the same method because it does not specify which turbines would be removed.

N/A = KOP is not influenced by WTG removal and is assumed to be the same impact as the Proposed Action.

Table 3.20-3. SLVIA Overall Impacts Per Landscape Character Area by Alternative as Determined in Appendix G Table G-VIS2a, Table G-VIS2b, Table G-VIS2c, Table G-VIS2d, Table G-VIS4a, Table G-VIS4b, Table G-VIS6a, Table G-VIS6b, Table G-VIS8a, Table G-VIS8b, Table G-VIS10a, and Table G-VIS10b

Character Area Name	Landscape Character Association (SCA/LCA/OCA)	SLIA Overall Impact Level for Alternative B	SLIA Overall Impact Level for Alternative C	SLIA Overall Impact Level for Alternative D	SLIA Overall Impact Level for Alternative E	SLIA Overall Impact Level for Alternative F*	SLIA Overall Impact Level for Alternative G
Shoreline Beach	SCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Coastal Bluff	SCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Developed Waterfront	SCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Shoreline Residential	SCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Coastal Dunes	SCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Salt Pond/ Tidal Marsh	SCA/LCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Inland Lakes and Ponds	SCA/LCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Maintained Recreation Area	SCA/LCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Highway Transportation	SCA/LCA	Moderate	Moderate	Moderate	Moderate	–	Moderate
Coastal Scrub/ Shrub Forest	LCA	Minor	Minor	Minor	Minor	–	Minor
Agricultural/ Open Field	LCA	Minor	Minor	Minor	Minor	–	Minor
Forest	LCA	Minor	Minor	Minor	Minor	–	Minor
Rural Residential	LCA	Minor	Minor	Minor	Minor	–	Minor
Suburban Residential	LCA	Minor	Minor	Minor	Minor	–	Minor
Village/ Town Center	LCA	Minor	Minor	Minor	Minor	–	Minor
Commercial	LCA	Minor	Minor	Minor	Minor	–	Minor
Open Ocean	OCA	Major	Major	Major	Major	–	Major

Notes: Nighttime impacts would be reduced to negligible, as described in EIS Table 3.3-2. Definitions of Potential Adverse Impact Levels, when FAA warning lights are not activated though the use of ADLS.

* Alternative F cannot be fully evaluated using the same method because it does not specify which turbines would be removed.

Table 3.20-4. SLVIA Overall Impacts Per Specially Designated Area by Alternative as Determined in Appendix G Table G-VIS2e, Table G-VIS4c, Table G-VIS6c, Table G-VIS8c, and Table G-VIS10c

Specially Designated Areas	SLIA Overall Impact Level for Alternative B	SLIA Overall Impact Level for Alternative C	SLIA Overall Impact Level for Alternative D	SLIA Overall Impact Level for Alternative E	SLIA Overall Impact Level for Alternative F*	SLIA Overall Impact Level for Alternative G
Historic Sites and National Landmarks	Major	Major	Major	Major	–	Major
National Natural Landmarks	Moderate	Moderate	Moderate	Moderate	–	Moderate
State Scenic Areas	Major	Major	Major	Major	–	Major
National Wildlife Refuges	Minor	Minor	Minor	Minor	–	Minor
State/ Non-Profit Wildlife management Areas	Minor	Minor	Minor	Minor	–	Minor
National Parks	Negligible	Negligible	Negligible	Negligible	–	Negligible
State Parks	Moderate	Moderate	Moderate	Moderate	–	Moderate
State Nature and Historic Preserves	Negligible	Negligible	Negligible	Negligible	–	Negligible
State Forests	Negligible	Negligible	Negligible	Negligible	–	Negligible
State Beaches	Moderate	Moderate	Moderate	Moderate	–	Moderate
Highways Designated or Eligible as Scenic	Moderate	Moderate	Moderate	Moderate	–	Moderate
National Historic Trails	Minor	Minor	Minor	Minor	–	Minor
National Recreational Trails	Major	Major	Major	Major	–	Major
State Fishing and Boating Access Sites	Moderate	Moderate	Moderate	Moderate	–	Moderate
Lighthouses	Major	Major	Major	Major	–	Major
Public Beaches	Moderate	Moderate	Moderate	Moderate	–	Moderate
Ferry Routes	Moderate	Moderate	Moderate	Moderate	–	Moderate
Seaports	Negligible	Negligible	Negligible	Negligible	–	Negligible
Other State Land with Public Access	Negligible	Negligible	Negligible	Negligible	–	Negligible

Notes: Nighttime impacts would be reduced to negligible, as described in EIS Table 3.3-2. Definitions of Potential Adverse Impact Levels, when FAA warning lights are not activated though the use of ADLS.

* Alternative F cannot be fully evaluated using the same method because it does not specify which turbines would be removed.

3.20.2.2 Alternative A: Impacts of the No Action Alternative on Visual Resources

3.20.2.2.1 Impacts of the No Action Alternative

Under the No Action Alternative, baseline conditions for visual resources (see Section 3.20.1) would continue to follow current regional trends and respond to IPFs introduced by other ongoing activities and by permitted and constructed offshore wind COP projects within the geographic analysis area. These IPFs are described and analyzed in Appendix E1.

3.20.2.2.2 Cumulative Impacts

This section discloses potential visual resources impacts associated with future offshore wind development (without the Proposed Action). The cumulative impact analysis for the No Action Alternative for planned non-offshore wind activities, as well as activities associated with constructed or approved offshore wind projects (without the Proposed Action), is provided in Appendix E1.

Offshore Activities and Facilities

Light: Development of offshore wind lease areas would increase the amount of offshore light sources associated with construction and installation, O&M, and decommissioning during the life of future projects. Lighting associated with night construction and decommissioning for future projects within BOEM lease areas would be localized and temporary and staggered over time; therefore, the lease areas would not have light sources across the entirety of the GAA at one time. However, light sources, depending on quantity, intensity, and location, could be visible from unobstructed sensitive onshore and offshore viewing locations based on viewer distance.

Field observations associated with visibility of FAA warning lighting (warning lighting) for the BIWF were conducted in May 2019 (HDR 2019). The BIWF consists of five WTGs with a blade tip height of approximately 600 feet. Observations of FAA nighttime lighting visibility under clear sky conditions in open water identified that warning lighting may be visible to the naked eye at a distance of 23.3 nm (26.8 miles) from the viewer (HDR 2019). The approximate 27-mile distance where the BIWF hub height drops below the visible horizon due to the curvature of the Earth and WTG height and viewer position influences the overall distance from which warning lighting may be visible. The BIWF report also concludes that daytime visibility of WTGs from land and water viewing locations is strongly dependent on weather conditions and distance (HDR 2019). Research related to the visibility of onshore WTGs in western landscapes (Sullivan et al. 2012) analyzed the visibility of FAA lighting at various distances and concluded that warning lighting was visible approximately 31.3 nm (36 miles) from viewing positions in broad, uninterrupted onshore landscapes, which would be a similar viewing condition as views across the open ocean setting. Of note, warning lighting may be visible beyond 36 miles, and the aforementioned study (Sullivan et al. 2012) had intervening topography that influenced visibility at the 36-mile distance. Therefore, it is assumed based on the referenced studies that the visibility of warning lighting may be visible anywhere from 23.3 nm (26.8 miles) to 31.3 nm (36 miles) or beyond.

Warning lighting systems would be used for the duration of Project O&M following BOEM guidelines (BOEM 2021a) for each reasonably foreseeable offshore wind project (876 WTGs). The amassing of these WTGs and associated synchronized flashing strobe lights affixed with a minimum of three red flashing lights at the midsection of each tower and two at the top of each WTG nacelle within the lease areas would have long-term **minor** to **major** adverse impacts to onshore and offshore KOPs based on viewer distance and angle of view and assuming no obstructions. Atmospheric and environmental factors such as haze and fog would influence visibility and perceivability of warning lighting from viewing locations. Additionally, long-term impacts associated with OCAs, SCAs, and LCAs would range from long term **minor** to **major** adverse based on the relationship of the character areas, lease areas inherent nighttime visual characteristics, and projects' inconsistences with those nighttime characteristics. Based on warning light viewshed analyses conducted as part of the VIA (EDR 2023:64), for analysis purposes, the following thresholds are considered as part of nighttime visual impacts: minor to negligible impacts are anticipated for distances beyond approximately 26 nm (30 miles); moderate impacts are anticipated for distances between approximately 17 nm (20 miles) and 26 nm (30 miles); and major impacts are anticipated for distances from viewer position out to 17 nm (20 miles). As noted above, overall visibility is based on viewer position, atmospheric conditions, and other environmental and intervening factors.

Implementation of an ADLS is an EPM (see Table F-1in Appendix F) and a component of the Proposed Action and action alternatives. The shorter duration synchronized flashing of the ADLS (activated as needed by nearby aircraft) would have reduced visual impacts at night as compared to the standard continuous, medium-intensity red strobe FAA warning light system. It is assumed that when FAA warning lights are not activated through the use of ADLS, nighttime impacts would be **negligible**. Based on a recent study by Capital Airspace related to ADLS efficacy associated with the RWF, historic air traffic data for flights passing through the warning light activation area indicated that the ADLS would have been activated for a total of 3 hours 35 minutes and 39 seconds over a 1-year period. Considering the local sunrise and sunset times, an ADLS warning light system could result in over a 99% reduction in warning light duration as compared to a traditional continuous warning light system (see COP Appendix S4 for ADLS efficacy analysis).

Lighting impacts would be most pronounced (although for a short duration with the implementation of an ADLS) for locations that can be currently characterized as undeveloped within the seascape both from an onshore and offshore perspective, where lighting from infrastructure and activities is not dominant or perceivable by the casual observer (viewer). Therefore, visual resource impacts would be short term during construction and long term during O&M, with **negligible** to **major** adverse impacts for a short duration of time to viewers based on the observed distances as categorized under the warning lighting impacts above and the anticipated activation time over the period of 1 year. Impacts to character areas would also be short term during construction and long term during O&M, with **negligible** to **major** adverse impacts for a short duration of time based on the relationship of the character areas, the lease areas' inherent nighttime visual characteristics, and projects' inconsistences with those nighttime characteristics. After decommissioning, the adverse impacts associated with O&M would cease.

<u>Presence of structures:</u> Planned future wind facility projects would consist of an estimated 897 WTGs and OSSs (see Table E4-1 in Appendix E4). In general, under clear daytime atmospheric conditions and depending on natural lighting angles, projects built within BOEM lease areas that are within 10.4 nm (12 miles) of character areas and viewing areas would have major adverse visual impacts, viewing areas beyond 10.4 nm (12 miles) up to 20.8 nm (24 miles) would have moderate to major adverse impacts, and viewing areas beyond 20.8 nm (24 miles) up to 26 nm (30 miles) would have minor adverse impacts (BOEM 2021b). Viewing areas that exceed 26 nm (30 miles) from projects would have negligible adverse visual impacts due to distance, the curvature of the Earth, and the influence of atmospheric conditions, which would decrease the ability of the viewer to discern or perceive projects at that distance. The combined visual effects of the planned project structures to KOPs, character areas, and SDAs, when

viewed from both onshore and offshore locations, would create long-term **negligible** to **major** adverse visual impacts. The overall impacts to KOPs, character areas, and SDAs would be dependent on geographic distance, curvature of the Earth, and orientation to the project; the elevation of the viewer; the degree of visibility considering lighting and atmospheric conditions; and the perceivable contrast, dominance, and scale of WTGs and OSSs along the horizontal plane of the ocean.

Onshore Activities and Facilities

Light: Future onshore planning projects within the GAA may require OnSSs, ICFs, O&M facilities, and port upgrades depending on project needs and may introduce additional or new infrastructure elements into SCAs and/or LCAs, although specific locations and project designs have not been determined. Infrastructure and associated nighttime lighting to support other offshore wind projects (e.g., OnSS O&M facilities) are anticipated to occur in areas of existing development or where similar infrastructure and development exist to aid in co-location of similar resources. Therefore, additional nighttime lighting sources associated with infrastructure to support other offshore wind projects would be a noticeable change over time and would have long-term **negligible** to **moderate** adverse impacts depending on the final location of infrastructure and additional lighting needs in relation to existing nighttime light sources.

Presence of Structures: Future onshore planning projects could require OnSSs, ICFs, O&M facilities, and port upgrades depending on project needs and could introduce additional or new infrastructure elements into the characteristic landscape over a period of time, although specific locations and design have not been determined. Infrastructure to support other offshore wind projects (e.g., OnSS O&M facilities) are anticipated to occur in or be co-located in areas of existing development associated with SCAs or LCAs where similar infrastructure and development exists based on trends in siting of these facilities associated with recent offshore wind projects. Therefore, the addition of structures to support other offshore wind projects would be noticeable over time and would have long-term **negligible** to **moderate** adverse impacts to identified KOPs, character areas, and SDAs depending on the final location of structures in relation to other built features in the characteristic landscape.

3.20.2.2.3 Conclusions

Under the No Action Alternative, BOEM would not approve the COP; Project construction and installation, O&M, and decommissioning would not occur; and potential impacts on the viewer's visual experience and character areas associated with the Project would not occur. However, ongoing and future offshore wind activities would have continued temporary to long-term adverse impacts, primarily through construction and O&M of WTGs and associated lighting.

BOEM anticipates that the range of impacts for reasonably foreseeable offshore wind activities would be **negligible** to **major** adverse for KOPs, character areas, and SDAs. BOEM anticipates that the range of impacts for ongoing activities and reasonably foreseeable activities other than offshore wind (as described in Appendix E) are anticipated to be **negligible** to **moderate** adverse as those ongoing activities and reasonably foreseeable activities would have less prominence and dominance as compared to offshore wind projects.

Considering all the IPFs together, BOEM anticipates that the impacts associated with future offshore wind activities in the GAA combined with ongoing activities, reasonably foreseeable environmental trends, and reasonably foreseeable activities other than offshore wind would result in **moderate** adverse impacts because the overall effect would be substantial, but the resource would be expected to recover completely after decommissioning.

3.20.2.3 Alternative B: Impacts of the Proposed Action on Visual Resources

3.20.2.3.1 Construction and Installation

Offshore Activities and Facilities

Light: The Proposed Action would require nighttime lighting for construction vessels traveling and working within the Lease Area as well as the addition of warning lighting systems at each WTG and OSS during an 8-month construction period. This lighting could be visible and impact the viewer's nighttime visual experience and inherent nighttime seascape character. During construction, visual impacts to potential nighttime viewers and the existing night sky environment would be temporary when associated with vessel traffic and construction lighting. Impacts would be long term, of short duration, and intermittent when associated with WTGs and OSSs warning lighting implementing ADLS. These impacts would be **negligible** to **major** adverse based on the observed viewer distance, as described in Section 3.20.1.1. Aquinnah Overlook (MV07), the closest occupied KOP to the Proposed Action, is located approximately 11.10 nm (13.7 miles) from the Proposed Action and the farthest KOP, Madeaket Beach (NI10), is located approximately 30.0 nm (34.6 miles) from the Proposed Action; these KOPs are representative of the minimum and maximum KOP distances in relation to perceivability of warning lighting. KOP distances in relation to the nearest WTG are further described in Appendix G.

Presence of structures: Up to 102 Project structures (WTGs and OSSs) are proposed for installation within the GAA. As noted under the No Action Alternative, these offshore structures would impact both viewers and character areas throughout construction until build-out completion. During construction, offshore and onshore viewers would see the upper portions of tall equipment such as mobile cranes and vessels. This equipment would move from each WTG and OSS location as construction progresses and thus would be temporary fixtures. Subsequently, the construction and installation of Project structures would occur during an approximate 8-month construction period, when there would be an appreciable change over time in seascape character and the viewer's visual experience resulting from the addition of up to two OSSs and 100 WTG structures. This appreciable change during the 8-month construction period as a result of the addition of Project structures to full build-out based on the WTG installation sequence; the temporary increase and concentration in vessel activity associated with construction, installation, and transport activities; and the addition of navigational marking and lighting would create short-term to long-term **negligible** to **major** adverse impacts to KOPs, with 16 of the 37 KOPs having major impacts. Impacts to SDAs would range from **negligible** to **major** adverse, with approximately 30,208 acres of visibility of the Proposed Action, or 14.5%, of the approximately 208,009 acres of SDAs. Impacts to the OCA as a result of the construction activities noted above would be **major** adverse (approximately 5,882 square miles, or 96.2%, of the total OCA within the GAA would have views of the Proposed Action). Impacts to SCAs and LCAs would range from **minor** to **moderate** adverse based on the sensitivity and degree of magnitude in relation to the character area; overall, the Project would be visible to approximately 35 square miles (2.4%) of the combined SCAs and LCAs within the GAA. Of the 60 impact determinations associated with KOPs, character areas, and SDAs, 21 major, 21 moderate, 11 minor, and seven negligible adverse impacts were determined for the Proposed Action. Further information related to impacts associated with the Proposed Action is located in Appendix G (see Tables G-VIS1a thru G-VIS2e).

Onshore Activities and Facilities

Light: Light from onshore construction activities could temporarily adversely impact viewers if located near the landing site, onshore cable route, and proposed onshore facilities. It is assumed that construction activities would occur during daylight hours. Fifteen publicly accessible KOPs were identified in the Visual Resource Assessment and Historic Resources Visual Effects Analysis within 3 miles of the OnSS and ICF, with the closest at approximately 0.6 mile distant (Narraganset Bay) (EDR 2021). Based on aerial imagery, approximately 500 feet south and west of the OnSS and ICF, there are residential properties consisting of single-family and multifamily residences. However, dense stands of tall trees, approximately 40-feet tall or greater, provide a natural buffer (approximately 300–350 feet thick) between the OnSS and ICF and the residences, which is anticipated to reduce any potential nighttime-related impacts to nearby residences to **negligible** adverse.

Nighttime lighting associated with the O&M facility at the Port of Davisville at Quonset Point would be localized (consisting of temporary nighttime safety and security lighting) because construction activities would occur during daylight hours. Based on viewer location and perspective in relation to existing onshore light sources, onshore lighting related to construction activity for the O&M facility would create short-term **negligible** adverse impacts to potential nighttime viewers and the existing night sky environment. Impacts associated with O&M facility would be associated with localized light sources associated with the facility and operational uses, similar to surrounding infrastructure.

Presence of structures: A new OnSS and ICF would be constructed to support interconnection of the Project to the existing electrical grid. Vegetation clearing associated with the access road and taller equipment (e.g., crane tip) may be visible from Camp Avenue or from surrounding residences during construction of these onshore structures. The construction and installation of the OnSS and ICF would occur during an approximate 18-month construction period. During this period, there would be a noticeable change over time in the immediate foreground of the OnSS and ICF because of the addition of the facilities. However, viewers would generally be screened and have obstructed views of construction activities because of the presence of existing development combined with densely forested areas that surround the facilities (EDR 2021).

The O&M facility at the Port of Davisville at Quonset Point would consist of two structures to house office space (approximately 1,000 square feet) and storage space (approximately 11,000 square feet) and located on the existing Air National Guard base. The structures, which are to be refurbished existing facilities, would be similar to existing industrial infrastructure, consisting of large geometric features. Therefore, the noticeable change during the 18-month construction period as a result of construction and installation activities and the addition of Project structures associated with the OnSS, ICF, and O&M facility would create long-term **negligible** adverse impacts to KOPs, character areas, and SDAs based on viewer location and perspective in relation to existing onshore structures and development.

3.20.2.3.2 Operations and Maintenance and Decommissioning

Offshore Activities and Facilities

Light: During O&M, the Proposed Action would contribute to nighttime lighting due to required warning lighting of up to 100 WTGs and two OSSs. During times when the warning lighting is activated, this lighting would add a developed-industrial visual element to views that were previously characterized by dark, open ocean. The addition of the ADLS would result in shorter duration night sky impacts to KOPs, character areas, and SDAs. Because of the limited duration and frequency of anticipated aviation warning activations and visibility of warning lighting, the Proposed Action would result in long-term, short duration, intermittent **negligible** to **major** adverse impacts to KOPs, character areas, and SDAs within distances described above. Impacts during decommissioning would be similar to the impacts during construction and installation: long term, short duration, and intermittent **negligible** to **major** adverse.

Presence of structures: The offshore components of the Project would be visible from coastal locations in New York, Connecticut, Rhode Island, and Massachusetts. Based on visual simulations as part of the VIA, the WTGs and/or OSSs would be all or partially visible on the horizon from shore where there are generally unobstructed views within the analysis area from 28 of the 37 KOPs evaluated (EDR 2023). The WTGs and OSSs would be painted RAL 9010 Pure White or RAL 7035 Light Grey in accordance with BOEM guidelines. The effects of sun lighting, shade, and shadows would cause backlit contrasts and higher impacts for onshore and offshore views from the northeast, north, and northwest in relation to sun angle. The color contrast varies due to sun angles and atmospheric clarity shifting from white WTGs against a blue or gray backdrop to a dark gray WTG against a light gray backdrop. Distance between the viewer and the WTGs along with the curvature of the Earth affect how much of the WTG is visible from viewer locations and influence its visible scale and dominance.

The up to 100 WTGs and two OSSs, as shown in the visual simulations in COP Appendix U3 (EDR 2023), would be viewed from variable distances along the ocean horizon depending on their distance from the 37 KOPs (7.6 nm [8.7 miles] minimum [it should be noted that this minimum distance was measured from Nomans Land Island which is an uninhabited island and National Wildlife Refuge] to 30 nm [34.6 miles] maximum) and result in variable degrees of impacts. Additionally, the curvature of the Earth, which influences the percentage of the turbine structure visible along the horizon is also a factor in the overall impacts. The WTGs would be more visually apparent when viewed from the northern and easterly shorelines due to the relationship of the Lease Area to KOPs (e.g., KOP MV02), which are approximately 11.8 nm (13.6 miles) distant. The scale of the 100 WTGs and two OSSs would become less perceivable as the distance from KOPs and/or character areas increases. Atmospheric and environmental factors such as haze, sun angle, time of day, cloud cover, fog, sea spray, and wave action would also influence visibility and perceivability from KOPs (e.g., NI10 - modified haze/sun, MV12 day vs. night, MV05 day vs. night), which may not be depicted in all visual simulations, or from other non-simulated locations that may have visibility within character areas. As a result, O&M would cause long-term **negligible** to **major** adverse impacts for the life of the Project. Impacts from decommissioning the 100 WTGs and two OSSs would be similar to construction impacts, **negligible** to **major** adverse.

Onshore Activities and Facilities

Light: Impacts would be reduced by the developer-committed EPM of switched vs. motion operational lighting, which would comply with local lighting regulations. Facility lighting would be mounted with the lamp horizontal to the ground (light facing straight down) or with a lamp tilt no more than 25 degrees from the horizon, which would direct light sources downward and localize any light disturbance (VHB 2023). Because of the similarity of the existing lighting of the adjacent Davisville Substation with the OnSS and ICF (lighting masts assumed to be approximately 20 feet in height), screening by mature vegetation throughout the area as noted in Section 3.20.2.2.1, and developer-committed EPMs, the nighttime lighting impacts of the OnSS and ICF would cause long-term **negligible** adverse impacts to potential nighttime viewers. Impacts during decommissioning would be similar to the impacts during construction and installation, short-term **negligible** to **minor** adverse.

Presence of structures: Based on the results of the viewshed analysis (EDR 2023), the OnSS and ICF infrastructure (buildings, lighting protection, and transmission structures) could be visible from approximately 15% (approximately 2,928 acres) of the 3-mile visual study area not accounting for the influence of vegetative screening defined in the onshore VIA. The presence of existing intervening landscape vegetation along roadways and other viewing locations could further reduce the extent of visibility. For views beyond 0.5 miles, for example Wickford Historic District, Wickford Harbor/Wickford Village State Scenic Area, and Narragansett Bay, visibility, considering distance, vegetation screening, viewer perspective, etc., is anticipated to be the top 10-feet of the overhead transmission line structures which are the tallest structure at approximately 80-feet (EDR 2021). Further discussion regarding potential impacts to viewsheds associated with historic or cultural viewsheds can be found in Section 3.10. Nevertheless, the OnSS and ICF would not be out of scale or character with the existing development present in the vicinity, which ranges from transit rail and four-lane roadway to residential to heavy industrial within 0.5 mile of the OnSS and ICF location. For this reason, the OnSS and ICF would result in long-term **negligible** adverse impacts to the viewer's and associated LCA. Impacts during decommissioning would be similar to the impacts during construction and installation.

3.20.2.3.3 Cumulative Impacts

Offshore Activities and Facilities

Light: Construction-related activities would add lighting used by offshore vessels and construction areas to the No Action Alternative. Construction of up to 100 WTGs and two OSSs would also add warning lighting to the No Action Alternative, which would be visible from several KOPs, character areas, and SDAs. New lighting from the Proposed Action would increase in-water structures with lighting impacts from past, present, and reasonably foreseeable future projects (assumed to be 893 structures) for a combined total of 995 lighted structures within the GAA, a 11% increase in lighting compared to the No Action Alternative (see Table E4-1). Nighttime vessel and construction area lighting during construction of the Proposed Action would be limited in duration and cease when construction is complete. Atmospheric and environmental conditions would influence visibility and perceivability from KOPs, character areas, and SDAs. Cumulatively, when combined with other past, present, and reasonably foreseeable future projects, the Proposed Action would result in long-term **negligible** to **major** adverse impacts to nighttime viewers and the existing night sky environment.

Presence of structures: Construction activities would add up to 100 additional WTGs and two OSSs to the No Action Alternative. As a result, approximately 90% of the total potential WTGs and OSSs in the GAA (995) would be associated with other future offshore wind development projects beyond the Proposed Action and at distances from KOPs, character areas, and SDAs where atmospheric conditions and the curvature of the Earth influence visibility. The position of the Proposed Action within the Lease Area, in relation to the other offshore wind development projects, shields or obscures visibility of those projects from KOPs in the northwestern to northeastern portions of the GAA (e.g., RI01, AIO5, and CI01). KOPs in these locations would have views of the Proposed Action as it is the closest project in relation to other projects. KOPs located along the western and eastern portions of the GAA (e.g., BI09, MV03, and NI10) would have increased visibility and therefore increased impacts related to future offshore wind projects in addition to the Proposed Action (see Table G-VIS9). When combined with other past, present, and reasonably foreseeable projects, the Proposed Action would result in long-term **negligible** (e.g., KOP MM 04) to **major** adverse cumulative impacts to KOPs, character areas, and SDAs. Adverse impacts would be removed at Project decommissioning.

Onshore Activities and Facilities

<u>Light:</u> Onshore construction and O&M would add an O&M facility, OnSS, and ICF with nighttime security lighting to the No Action Alternative. These onshore structures and nighttime lighting sources would occur in areas of existing development or where similar infrastructure and development exists; would use or replace existing structures (O&M facility); and when considered cumulatively with past, present, and reasonably foreseeable activities would result in long-term **negligible** adverse impacts to the viewer's nighttime visual experience and inherent nighttime landscape character.

<u>Presence of structures:</u> Onshore construction and installation would add an ICF, and OnSS to the No Action Alternative. The O&M facility would use existing structures. The Proposed Action does not include any updates to ports. Any potential future port upgrades required to service the offshore wind industry would potentially result in similar **negligible** adverse visual impacts to KOPs, character areas, and SDAs. The Proposed Action when combined with past, present, and reasonably foreseeable activities would result in long-term **negligible** adverse cumulative impacts to KOPs, character areas, and SDAs.

3.20.2.3.4 Conclusions

Project construction and installation, O&M, and decommissioning would introduce visible vessels, structures, and warning lighting to the GAA. BOEM anticipates the impacts resulting from the Proposed Action alone would range from short term to long term **negligible** to **major** adverse. Of the 60 impact determinations associated with KOPs, character areas, and SDAs, 21 major, 21 moderate, 11 minor, and seven negligible adverse impacts were determined for the Proposed Action (see Appendix G); therefore, BOEM anticipates the overall impact on KOPs, character areas, and SDAs from the Proposed Action to be **long term moderate to major adverse because** the overall effect would be substantial to dominant based on the largest number of impact determinations for the for the life of the Project, but the resource would be expected to recover completely after decommissioning. BOEM anticipates that the overall impacts associated with the Proposed Action when combined with past, present, and reasonably foreseeable activities would be **negligible** to **major** adverse to KOPs, character areas, and SDAs. Decommissioning after a project's life of up to 35 years would remove the cumulative visual impacts of the Project.

3.20.2.4 Alternatives C, D, E, and F

Table 3.20-1 provides a summary of IPF findings for these alternatives.

3.20.2.4.1 Conclusions

Project construction and installation, O&M, and decommissioning would introduce visible vessels, structures, and warning lighting to the GAA. Analysis findings that identify an action alternative associated with Alternatives C, D, E, and F that has the greatest potential for reduced visual impacts (least impactful) as a result of the removal of turbines in relation to KOPs or character areas, have been carried forward in Table 3.20-1 rather than describe impacts for all action alternatives where differences are negligible. Of the 12 action alternatives (C, D, E, and F); four alternatives (C1, D1+D2+D3, E1, and F) were determined to have a lesser degree of visual impacts to KOPs and SCAs than the remaining eight action alternatives and are described below.

Alternatives C1 and C2: Because of WTG placement, Alternative C2 would result in slightly lesser degree of impacts than Alternative C1. Alternative C2 would result in short-term to long-term **negligible** to **major** adverse impacts to KOPs, with 10 of the 17 selected KOPs having major adverse impacts, four KOPs having moderate adverse impacts, and three KOPs having minor to negligible adverse impacts. Impacts to SDAs would range from **negligible** to **major** adverse, with approximately 29,967 acres of visibility of Alternative C2 (14.4%) of the approximately 195,701 acres of SDAs. Impacts to the OCA would be **major** adverse, similar to other action alternatives, with approximately 96% of the OCA having visibility of Alternative C2. Impacts to SCAs and LCAs would range from **minor** to **moderate** adverse based on the sensitivity and degree of magnitude in relation to the character area; overall, Alternative C2 would be visible to approximately 34.7 square miles (2.3%) of the combined SCAs and LCAs within the GAA. Due to the similarity in placement of WTGs, Alternatives C1 and C2 would result in similar impacts, and both alternatives would result in fewer impacts than the Proposed Action. Of the 40 impact determinations associated with KOPs, character areas, and SDAs, 14 major, 13 moderate, eight minor, and five negligible adverse impacts were determined for Alternative C2 (Tables G-VIS3 and G-VIS4c).

Alternative D alternatives: Of the seven Alternative D alternatives, Alternative D1+D2+D3 would result in the least number of adverse impacts because of the combination of removed turbines as compared to the maximum-case scenario for the Proposed Action. Alternative D1+D2+D3 would result in short-term to long-term **negligible** to **major** adverse impacts to KOPs within the GAA, with 12 of the 37 selected KOPs having major adverse impacts, 14 KOPs having moderate adverse impacts, and 11 KOPs having minor to negligible adverse impacts. Impacts to SDAs would range from **negligible** to **major** adverse, with approximately 28,840 acres of visibility of Alternative D1+D2+D3 (13.9%) of the approximately 208,009 acres of SDAs. Impacts to the OCA would be **major** adverse, similar to other action alternatives, with approximately 96% of the OCA having visibility of the Project. Impacts to SCAs and LCAs would range from **minor** to **moderate** adverse, similar to the Proposed Action, based on the sensitivity and degree of magnitude in relation to the character area. Overall, approximately 31.1 square miles (2.1%) of the combined SCAs and LCAs would have visibility of Alternative D1+D2+D3 within the GAA. Of the 60 impact determinations associated with KOPs, character areas, and SDAs, 15 major, 24 moderate, 12 minor and 9 negligible impacts were determined for Alternative D1+D2+D3 (Tables G-VIS5a and G-VIS6c).

Alternative E1 and E2: Because of the placement of WTGs, Alternative E1 would result in slightly fewer impacts than Alternative E2. Alternative E1 would result in short-term to long-term **negligible** to **major** adverse impacts to KOPs within the GAA, with four of the 21 selected KOPs having major adverse impacts, 12 KOPs having moderate adverse impacts, and five KOPs having minor to negligible adverse impacts. The removal of WTGs from the central and northern portions of the Lease Area would increase the distance between KOPs and WTGs in those portions of the Lease Area. Views of WTGs from KOP MV07 (Aquinnah Overlook), for example, would be similar to the Proposed Action at the far-left field of view and to the right of Nomans Land Island where WTGs have not been removed and are the nearest WTGs to KOP MV07 (approximately 13 nm as indicated in Appendix G Table G-VIS7 as the worst case scenario). Within the field of view continuing to pan from left to right where WTGs have been removed, WTGs would increase in distance from the KOP and range from approximately 14 nm (center left) to approximately 18 nm (far right) (Figure 3.20-2).

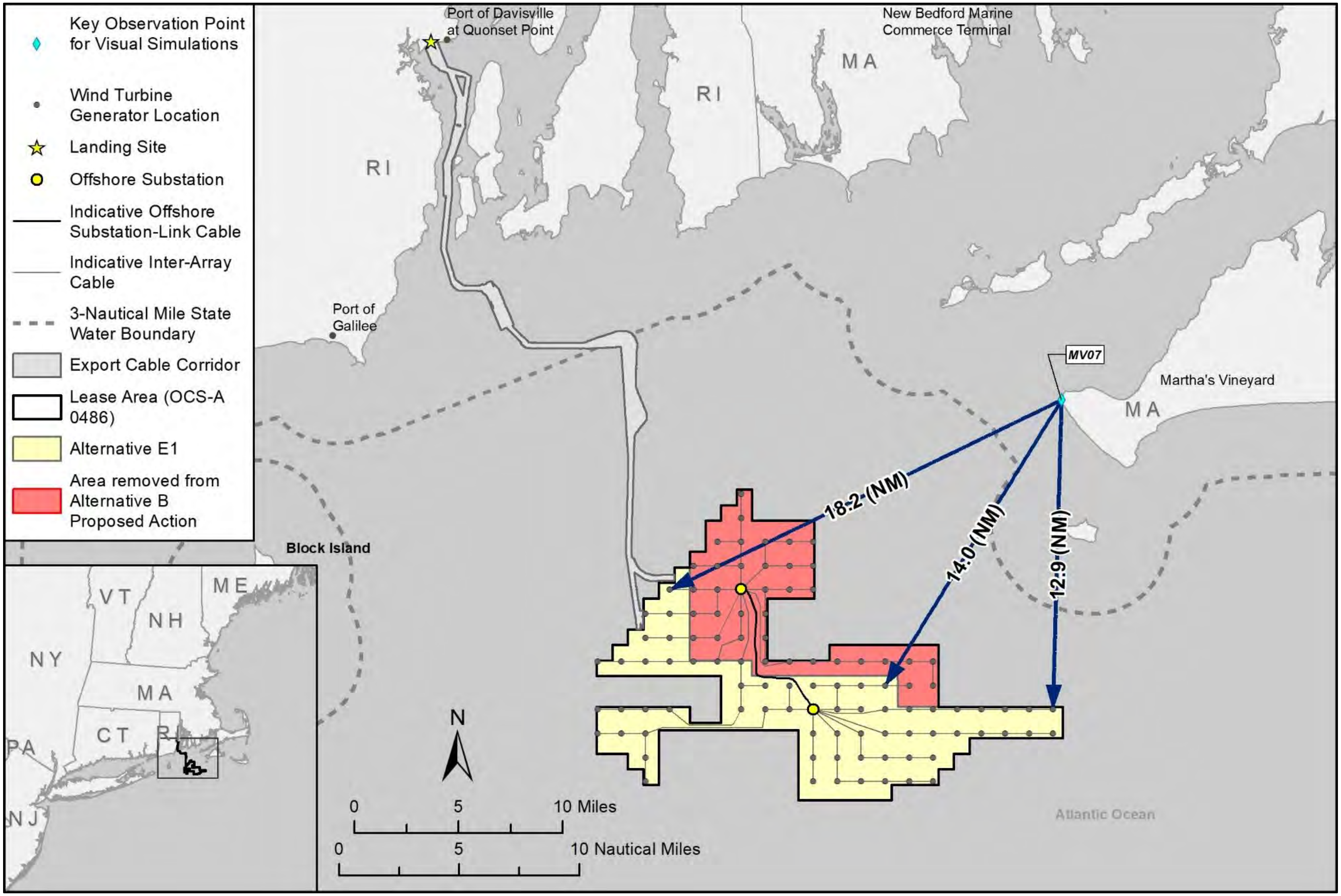

Figure 3.20-2. Alternative E1 - nearest wind turbine generator to KOP MV07.

Impacts to SDAs would range from **negligible** to **major** adverse. with approximately 29,085 acres of visibility of Alternative E1 (14.0%) of the approximately 208,009 acres of SDAs. Impacts to the OCA would be **major** adverse, similar to the Proposed Action, with approximately 96% of the OCA having visibility of the alternative. Impacts to SCAs and LCAs would range from **minor** to **moderate** adverse based on the sensitivity and degree of magnitude in relation to the character area. Overall, approximately 32.7 square miles (2.2%) of the combined SCAs and LCAs would have visibility of Alternative E1 within the GAA. Of the 44 impact determinations associated with KOPs, character areas, and SDAs, eight major, 21 moderate, seven minor, and eight negligible adverse impacts were determined for Alternative E1 (see Tables G-VIS7 and G-VIS8c).

Alternative E2 would result in short-term to long-term **negligible** to **major** adverse impacts to KOPs within the GAA; with one of the 16 selected KOPs having major adverse impacts, six KOPs having moderate adverse impacts, and nine KOPs having minor to negligible adverse impacts. The removal of WTGs from the northern and northwest portions of the Lease Area associated with Alternative E2 would increase the distance between the Rhode Island and Block Island KOPs and the viewer's field of view. The size and scale of impact to views of WTGs as seen from KOP MV07 (Aquinnah Overlook) would be similar to the Proposed Action; however, the removal of WTGs at the far-right proximity of the Lease Area (approximately 11.9 nm) would reduce the western encroachment into the sunset view; therefore, the overall field of view of WTGs would be reduced as compared to the Proposed Action (Figure 3.20-3).

Impacts to SDAs would range from **negligible** to **major** adverse, with approximately 29,385 acres of visibility of Alternative E2 (14.1%) of the approximately 208,009 acres of SDAs. Impacts to the OCA would be **major** adverse, similar to the Proposed Action, with approximately 96% of the OCA having visibility of the alternative. Impacts to SCAs and LCAs would range from **minor** to **moderate** adverse based on the sensitivity and degree of magnitude in relation to the character area. Overall, approximately 33.5 square miles (2.3%) of the combined SCAs and LCAs would have visibility of Alternative E2 within the GAA. Of the 39 impact determinations associated with KOPs, character areas, and SDAs, five major, 15 moderate, seven minor, and 12 negligible adverse impacts were determined for Alternative E2 (see Tables G-VIS7 and G-VIS8c).

Alternatives E1 and E2 would not have as great of a reduced visual impact within the GAA. Because of the specific nature and development of Alternatives E1 and E2 related to reducing visual impacts to specific KOPs along the northeastern portion of the Lease Area associated with Martha's Vineyard (e.g., MV08, Aquinnah Overlook and MV12, Peaked Hill), KOPs in this geographic area would have greater reduced visual impacts as compared to other action alternatives. Additionally, some KOPs that are at a greater distance (e.g., AI05 [Sachuest Point National Wildlife Refuge]) would also have reduced visual impacts based on orientation to the Lease Area.

Further information related to impacts to individual KOPs, character areas, and SDAs associated with Alternatives C, D, and E is included in Appendix G.

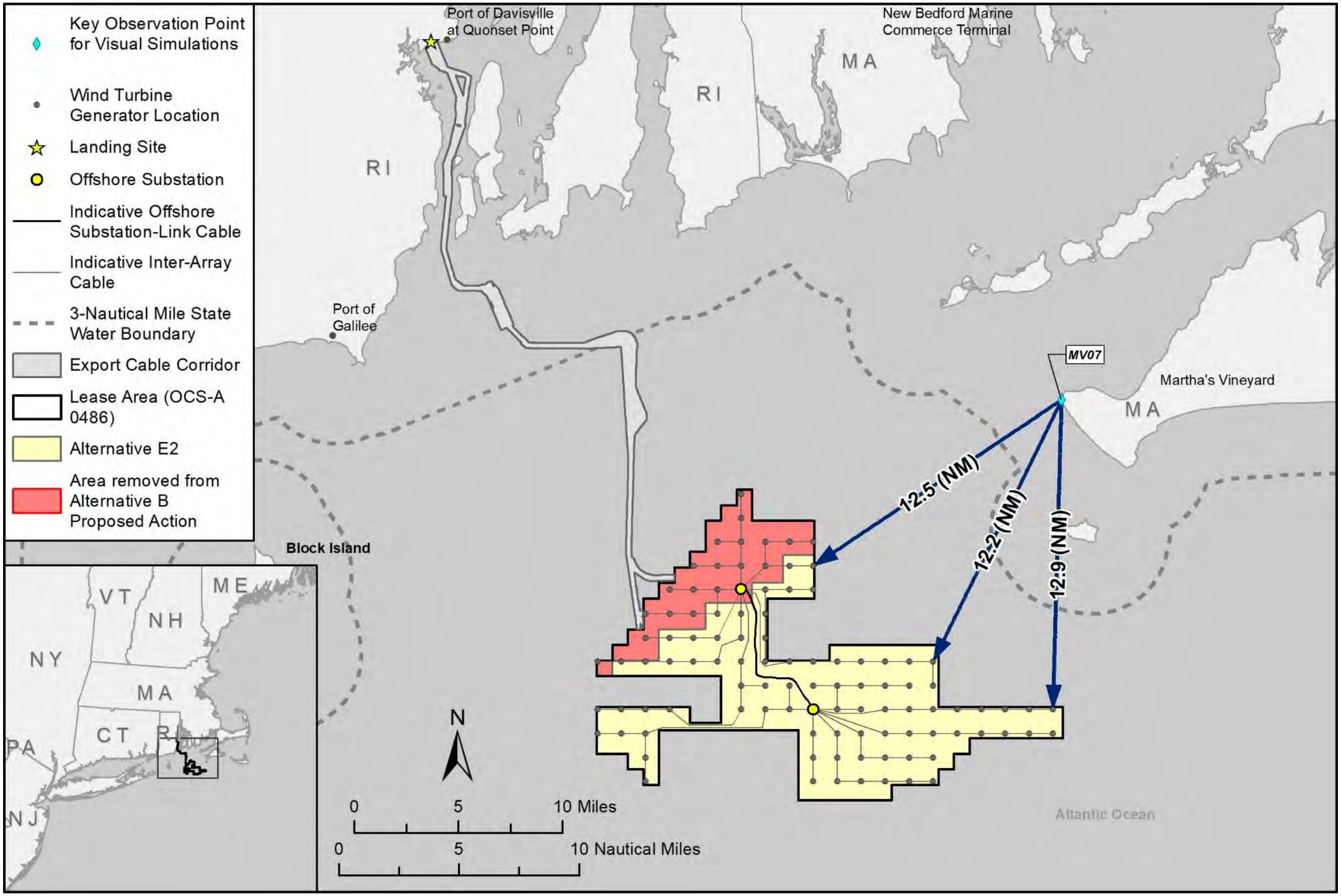

Figure 3.20-3. Alternative E2 - nearest wind turbine generator to KOP MV07.

Alternative F would reduce the number of WTGs installed in the Lease Area as compared to the maximum-case scenario for the Proposed Action or any action alternative that it is combined with. The potential reduction of impacts would depend on viewer distance and be focused primarily on locations in closest proximity to the area of reduced WTGs. A reduction in WTGs installed would be expected to result in long-term **negligible** to **major** adverse impacts to KOPs, character areas, and SDAs. However, the application of Alternative F cannot be fully evaluated until the specific WTGs to be removed are identified.

In the context of other reasonably foreseeable environmental trends and planned actions, BOEM anticipates that the overall impacts associated with Alternatives C2, D1+D2+D3, E1, and F or any other alternative option when combined with past, present, and reasonably foreseeable activities would be **negligible** to **major** adverse. This impact determination is due to the proximity of the Project within the Lease Area and in relation to KOPs, character areas, and SDAs. Additionally, impacts would be variable based on the final alternative selected and range from 1,011 to 1,048 structures (WTGs and OSSs). Decommissioning would remove the cumulative visual impacts of the Project.

3.20.2.5 Alternative G: Impacts of the Preferred Alternative on Visual Resources

Table 3.20-1 provides a summary of IPF findings for this alternative.

3.20.2.5.1 Conclusions

Because of the placement of WTGs in relation to KOPs, Alternatives G2 and G3 would have the greatest reduced visual impact as compared to the Proposed Action. Information related to overall impact determinations for Alternatives G and G1 is included in Appendix G. Alternative G2 would result in fewer impacts than Alternative G3. Alternative G2 would result in short-term to long-term **negligible** to **major** adverse impacts to KOPs within the GAA, with one of the 19 selected KOPs having major adverse impacts, 10 KOPs having moderate adverse impacts, and four KOPs having minor to negligible adverse impacts. Comparatively, Alternative G3 would have 10 of the 22 selected KOPs with major adverse impacts, seven KOPs with moderate adverse impacts, one KOP with minor impacts, and four KOPs with negligible adverse impacts.

Impacts to SDAs would range from negligible to major adverse under Alternative G, with Alternative G2 having the greatest reduced visibility with approximately 30,499 acres of visibility (14.6%) of the approximately 208,009 acres of SDAs as compared to 30,477 acres of visibility (14.7%) associated with Alternative G3. Impacts to the OCA would be major adverse, similar to other action alternatives, with Alternative G visible to approximately 96% of the OCA.

Impacts to SCAs and LCAs would range from **minor** to **moderate** adverse based on the sensitivity and degree of magnitude in relation to the character area; overall, Alternative G3 would be the least visible to approximately 33.4 square miles (2.2%) of the combined SCAs and LCAs within the GAA as compared 33.5 square miles (2.3%) associated with Alternative G2. Of the 42 impact determinations associated with KOPs, character areas, and SDAs, six **major**, 19 **moderate**, eight **minor**, and nine **negligible** adverse impacts were determined for Alternative G2 as compared to 10 **major**, seven **moderate**, one **minor**, and four **negligible** adverse impacts associated with Alternative G3 (see Tables G-VIS9 to G-VIS10c).

Further information related to impacts to individual KOPs, character areas, and SDAs associated with Alternative G is included in Appendix G.

In the context of other reasonably foreseeable environmental trends and planned actions, BOEM anticipates that the overall impacts associated with Alternatives G when combined with past, present, and reasonably foreseeable activities would be negligible to major adverse. This impact determination is due to the proximity of the Project within the Lease Area and in relation to KOPs, character areas, and SDAs. Additionally, impacts would be variable based on the final alternative selected and range from 964 to 978 structures (WTGs and OSSs). Decommissioning would remove the cumulative visual impacts of the Project.

3.20.2.6 Mitigation

No mitigation measures resulting from agency consultations for visual resources are identified in Appendix F, Table F-2. Additional mitigation measures identified by BOEM and cooperating agencies are listed in Appendix F, Table F-3, and addressed in Table 3.20-5.

Table 3.20-5. Additional Mitigation and Monitoring Measures for Visual Resources (Appendix F, Table F-3)

Mitigation Measure	Description	Expected Effect on Impacts from Action Alternatives
Visual impacts monitoring plan	Monitoring visual effects during construction and operations in the daytime and nighttime	This measure would not modify the impact determination for visual resources but would provide the information necessary to ensure that these effects do not exceed the levels analyzed herein.

3.20.2.6.1 Measures Incorporated into the Preferred Alternative

Mitigation measures resulting from consultations, authorizations, and permits listed in Table 3.20-5 and in Appendix F, Table F-2, are incorporated into Alternative G (Preferred Alternative). The visual impacts monitoring plan, if adopted, would further define how the effectiveness and enforcement of EPMs would be ensured. This mitigation measure would improve accountability for compliance with EPMs by requiring the submittal of plans for approval by the enforcing agency(ies) and by defining reporting requirements. Because this measure ensures the effectiveness of and compliance with EPMs, as part of a formalized monitoring plan, that is already analyzed as part of the Proposed Action, implementation of this measure would not further reduce the impact level of the Proposed Action from what is described in Section 3.20.2.3.

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3.21 Water Quality

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to water quality from implementation of the Proposed Action and other considered alternatives.

3.22 Wetlands and Non-tidal Waters

The reader is referred to Appendix E2 Assessment of Resources with Minor (or Less) Impact Determinations for a discussion of current conditions and potential impacts to wetlands and non-tidal waters from implementation of the Proposed Action and other considered alternatives.